Cretaceous and Tertiary Faults
in
Southwestern Alabama

Edited by

C. W. Copeland, J. G. Newton, and D. M. Sell

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A Guidebook for the
Fourteenth Annual Field Trip

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Alabama Geological Society

November 19-20, 1976

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CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS - continued

INTRODUCTION

The definition of anomalous geologic structures in the outcrop is extremely important throughout Alabama as it is elsewhere. Faulting mapped at the surface aids in the interpretation of subsurface data that might define traps that are sources of oil and gas. Faults, even relatively small ones, have determined or can determine whether mining at the surface or in the subsurface is economically feasible. This has been and will be especially important in the coal, lignite, limestone, dolomite, marble, and hematite industries.

The occurrence of faults in indurated sedimentary, metamorphic and igneous rocks in northern and eastern Alabama also allows an evaluation of resources and problems not related to the field of energy. A fault in indurated rocks can indicate permeability where large sources of potable ground water are transmitted or stored that might be available for public supply or industrial use. The mapping of such a fault involving carbonate rocks may also indicate areas of potential subsidence in the event that the aquifer is dewatered or pumped at an excessive rate. The mapping of a fault in younger unconsolidated sediments in the Coastal Plain of Alabama can also indicate a zone in which water may be sufficiently mineralized to eliminate its value for most uses. The presence of a fault and the determination of its age also allows an interpretation of its potential movement and relationships to possible earthquake activity. This is extremely important in evaluating potential nuclear power generating sites.

The surface geology of most of the area transversed by this field trip has been mapped as a part of cooperative investigations by the Geological Survey of Alabama and the U.S. Geological Survey. Information pertaining to numerous faults discussed in this guide book and at several stops resulted from those investigations.

Faults in the Coastal Plain of Alabama are not generally well defined in the outcrop. Fault planes are rarely exposed and many faults have yet to be mapped. This is due to deep weathering that results from climatic conditions, extensive covering of bedrock by Quaternary terrace and alluvial deposits, and the lack of recognizable marker beds in broad areas underlain by some geologic units of Paleocene, Eocene, Miocene and Pliocene age.

ACKNOWLEDGMENTS

The field trip committee wishes to express its sincere thanks to the following staff members of the Geological Survey of Alabama for their assistance in preparing the guidebook: Mr. Thomas J. Joiner, Acting State Geologist and Oil and Gas Supervisor provided support and constructive suggestions; Mrs. Merla W. Elliott typed the preliminary drafts of the manuscripts, and; Mr. Samuel W. Shannon assisted with the preparation of the illustrations. The support of Mr. William J. Powell, District Chief, Water Resources Division, U.S. Geological Survey, University, Alabama, is also gratefully acknowledged.

FAULTS IN THE SELMA GROUP (LATE CRETACEOUS) OF WEST-CENTRAL ALABAMA[1]

By Donald M. Self[2]

Formations in the Selma Group of Late Cretaceous age in west-central Alabama crop out in an arcuate belt that generally strike northwestward (fig. 1). There the beds in the Selma Group generally dip to the southwest at approximately 30 to 40 feet (ft) per mile (mi)(5.7 to 7.6 meters [m] per kilometer [km]). This gentle dip is interrupted by a number of broad low amplitude folds and by both normal and reverse faults. Faulting apparently occurred in at least two stages. The first occurred prior to lithification of the Prairie Bluff Chalk, while the second stage occurred after lithification of the Selma Group possibly extending well into the Tertiary. The origin of these faults is still the subject of some controversy. They can, however, be readily differentiated on the basis of the characteristics of their fault planes.

STRATIGRAPHY

The Selma Group is composed of, in ascending order: the Mooreville Chalk, Demopolis Chalk, Ripley Formation, and Prairie Bluff Chalk (fig. 2). The Mooreville Chalk, which unconformably overlies the Tombigbee Sand Member of the Eutaw Formation, is a light-gray marl or calcareous clay with locally chalky facies. A compact calcareous sandstone, containing scattered quartz pebbles, phosphatic pellets, and phosphatic molds of fossil shells occurs near the base of the formation. The Arcola Limestone Member is located at the top of the formation and is composed of alternating hard and soft chalk and limestone beds. It represents a lithologic transition from the calcareous clay of the Mooreville to the relatively pure chalk of the overlying Demopolis Chalk. The thickness of the Mooreville Chalk in western Alabama ranges from 225 to 860 ft (69 to 110 m).

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[1] Research supported in part by U.S. Geological Survey Research Grant No. 14-08-0001-G-145.

[2] Alabama Development Office, Montgomery, Alabama.

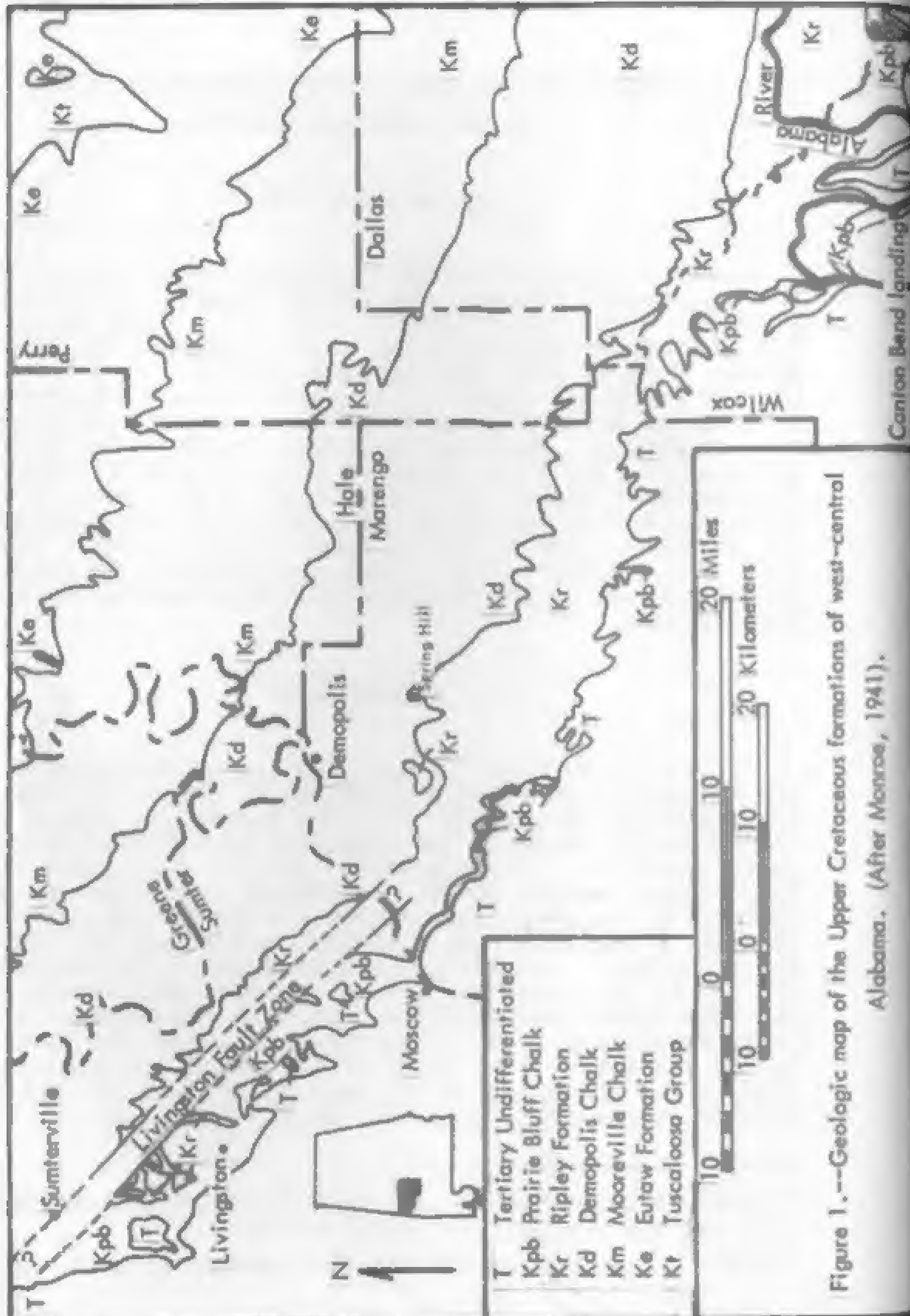


Figure 1.--Geologic map of the Upper Cretaceous formations of west-central Alabama. (After Monroe, 1941).

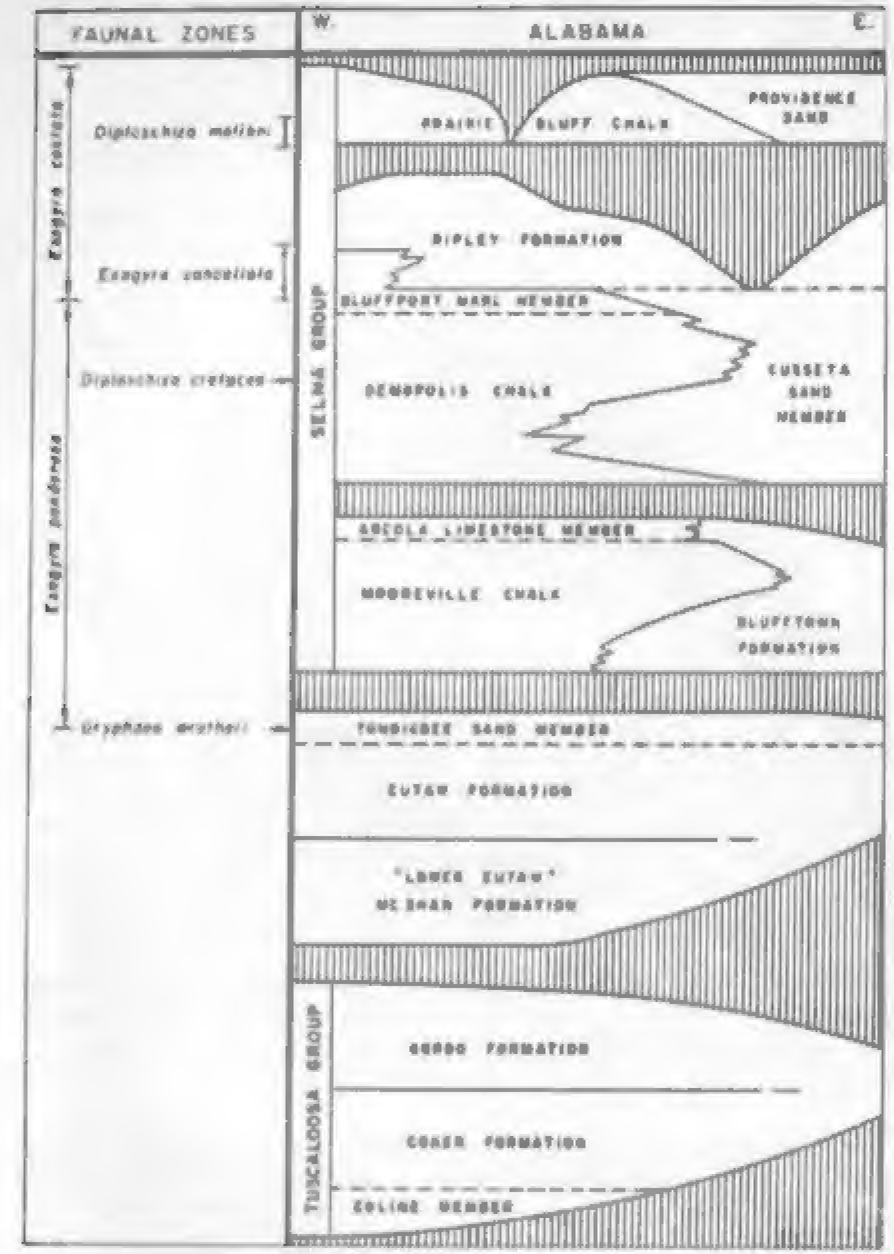


Figure 2.--Correlation chart of Upper Cretaceous formations in Alabama showing faunal zones. (Modified from LaMoreaux and Toulmin, 1959).

The Demopolis Chalk is composed of approximately 450 to 520 ft (137.2 to 158.5 m) of massive to thin-bedded brittle chalk and calcareous clay. Contacts between beds are gradational and are difficult to distinguish except in weathered bluffs. The upper 60 to 65 ft (18.3 to 19.8 m) of the Demopolis Chalk, the Bluffport Marl Member, consists of fossiliferous clayey chalk and sandy calcareous clay.

The Ripley Formation overlies the Demopolis Chalk and consists of micaceous, fine-grained quartz sand and sandstone and light-gray calcareous micaceous sandy silt with some indurated, very sandy limestone beds. The Ripley Formation is 70 to 220 ft (21.3 to 67.1 m) thick in Sumter and Marengo Counties with post-Ripley uplift and erosion apparently responsible for the variation. The Ripley Formation is unconformably overlain by the Prairie Bluff Chalk.

The Prairie Bluff Chalk consists of light-gray massive to medium-bedded fossiliferous sandy chalk that ranges from 10 to 90 ft (3.0 to 27.4 m) in thickness. The Prairie Bluff Chalk is unconformably overlain by the Clayton Formation of Paleocene age.

The Clayton Formation ranges from 3 to 20 ft (0.9 to 6.1 m) in thickness and is composed of a lenticular basal cross-bedded glauconitic sandstone and conglomerate and an upper fossiliferous sandy calcareous clay. The basal sandstone was deposited in depressions in the underlying Prairie Bluff Chalk and is separated from the upper unit by an unconformity that is indicated by a zone of borings and the angular relationships of the beds above and below the contact.

The Clayton Formation is overlain by the Porters Creek Formation. The lower part of the Porters Creek is composed of a medium-bedded silty calcareous clay which grades upward into dark-gray massive marine clay.

Within its outcrop area, the Selma Group is locally covered by a series of river terraces developed along the Tombigbee and Alabama Rivers and their major tributaries. These alluvial terrace deposits are variable in thickness and usually grade upward from basal gravels to silt or clay. The oldest terraces cap hills fartherest from the rivers, while younger terraces occupy lower elevations nearer the rivers.

STRUCTURE

Structural features affecting the Selma Group include broad, low amplitude folds, joints, and normal and reverse faults. These features are best exposed in the nearly continuous bluffs along the Tombigbee River in Sumter and Marengo Counties and in the bluffs of the Alabama River in Dallas and Wilcox Counties.

The faults which displace Upper Cretaceous and Paleocene formations exhibit a number of characteristics which are apparently related to their time of origin. The oldest faults are apparently characterized by zones of plastic flow which were formed prior to lithification of the sediments. Displacement may be either normal or reverse and ranges from a few inches (in)(centimeters [cm]) to as much as 90 ft (27.4 m). The fault planes of the later stage of faulting are characterized by features normally associated with brittle fractures, including slickensides, clay gouge, and tension fractures. Displacement on these faults is classified as either normal or unresolved (normal ?) depending upon whether the sense of displacement can be determined.

LIVINGSTON FAULT ZONE

The Livingston fault zone interrupts the regional dip of the formations composing the Selma Group in a long narrow belt extending southeastward from a point west of Sumterville in northwest Sumter County to the vicinity of Old Spring Hill in north-central Marengo County (Monroe, 1941; Monroe and Hunt, 1958; and Newton, Sutcliffe, and LaMoreaux, 1961). The strata are broken into a series of parallel horsts and grabens that strike generally N 70° W and are bounded by high-angle reverse faults. Displacement along these faults may exceed 90 ft (17.4 m) but appears to average about 40 ft (12.2 m). The Demopolis Chalk, Ripley Formation, and Prairie Bluff Chalk are offset by these faults. Because the fault zone is located several miles (kilometers) north of the outcrop of Tertiary rocks, it is impossible to determine if strata of Tertiary age were deposited prior to faulting. Near the Tombigbee River, the reverse faults are unconformably overlain by Quaternary terrace deposits. As only the relative age of the faults can be determined, the reverse faults of the Livingston fault zone are considered to have formed after deposition of the Prairie Bluff Chalk and prior to deposition of the Quaternary high terrace deposits of the Tombigbee River. The presence of well developed drag folds in the Ripley Formation (fig. 3) and fault planes that are marked by zones of plastic flow containing undeformed macrofossils indicate that faulting occurred prior to lithification of the Prairie Bluff. Where reverse faults displace relatively older strata, the development of these zones of plastic flow is less pronounced. Reverse faults exposed within the Demopolis Chalk along the Tombigbee River rarely exceed 6 in (15.2 cm) in width.

A second type of fault occurs within the Livingston fault zone. These faults are high-angle normal and unresolved (normal ?) faults which displace both the reverse faults and strata of the Selma Group. These faults apparently formed after lithification of the affected strata and are characterized by the presence of up to several inches

Figure 3.--High-angle reverse fault in the Livingston fault zone. Thin- to medium-bedded calcareous sand of the Ripley Formation (Kr) is thrust over massive sandy chalk of the Prairie Bluff Chalk (Kpb). Note drag folds in the Ripley strata.

(centimeters) of slickensided calcite filling the fault planes. The fault planes are usually curved and displacements are generally small, rarely exceeding one foot (0.3 m). Although these faults may parallel the major reverse faults, they generally strike at an oblique angle to the trend of the Livingston fault zone.

The calcite is apparently the product of dissolution and recrystallization of the calcareous clay gouge observed in association with other normal faults in the Selma Group. Frequently, the calcite forms a fault breccia by cementing relatively undeformed angular to well-rounded slickensided fragments of chalk. The crystals of calcite, however, are undeformed and appear to have grown away from individual shear surfaces. Multiple small displacements are indicated by the fact that these calcite fillings actually consist of a number of thin layers of undeformed calcite which are bounded by slickensides formed by each successive displacement. Displacement on each shear can be accurately determined only when multiple displacements occur within a fault breccia.

The origin of the Livingston fault zone remains the subject of some controversy. Monroe and Hunt (1958) offered no suggestion to account for the faulting although they did imply the existence of a relationship between faulting and the uplift immediately southwest of the Livingston fault zone. They also called attention to the similarity between the Livingston fault zone and "ribbon faulting" in the Moab district, Utah (Baker, 1933), where faulting apparently resulted from the solution of salt beneath a syncline. Monroe and hunt concluded that although no salt is known under the Livingston area, "it is possible that the faulting is related in some way to salt that may have been under the area at some time in the past."

Schneeflock (1972) suggested that the reverse faults formed as the result of localized horizontal compression in the trough of a northwest-southeast trending syncline produced by movement along a flexure in the Paleozoic basement. Paulson (1974) hypothesized that the compressive stress which produced the reverse faults of the Livingston fault zone was produced by right lateral movement along a wrench fault in the basement and "bears the proper relationship to the direction of greatest strain for thrusting or reverse faulting."

Neither Monroe and Hunt's (1958) conclusion nor Paulson's (1974) hypothesis withstand close scrutiny. There is no evidence to indicate that the Livingston area has ever been underlain by salt deposits which effectively rules out salt tectonism as a causal mechanism. Paulson (1970 and 1974) indicates that movement along his basement wrench fault occurred during the Pennsylvanian and/or Permian Periods, more than one-hundred million years prior to deposition of the Selma Group.

Only Schneeflock's (1972) hypothesis is supported by geologic evidence. The Livingston fault zone does occupy either a broad syncline or a structural terrace and normal faults similar to those that offset Pennsylvanian strata in the Warrior basin probably occur in the Paleozoic subcrop beneath the Livingston area. Whether a basement flexure exists under the Livingston area is unknown; however, movement along post-Pennsylvanian normal faults which probably do occur could have produced the down-warping which resulted in the formation of local compression and the reverse faults of the Livingston fault zone.

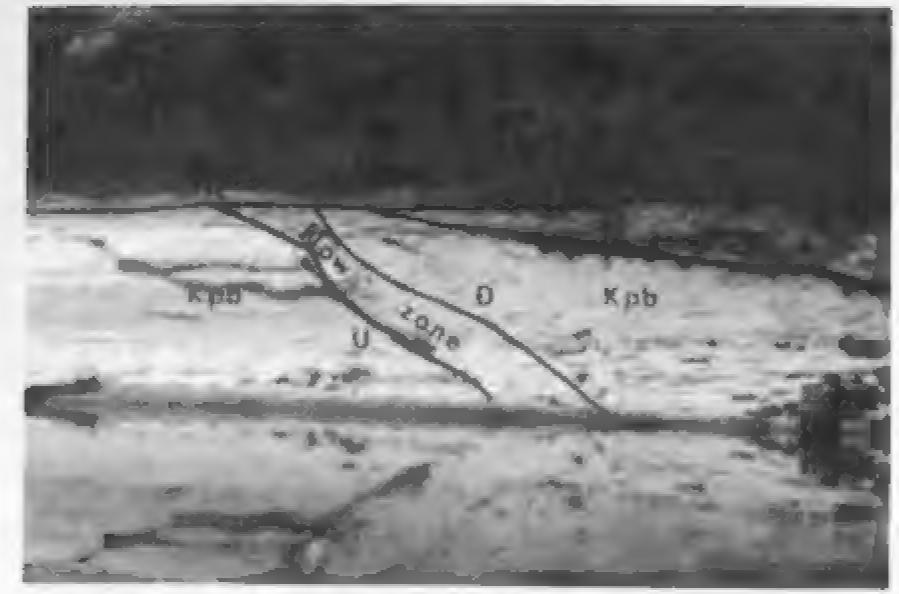
No satisfactory explanation exists for the origin of the calcite filled normal and unresolved (normal ?) faults observed in the Livingston fault zone. Some are undoubtedly related to the stresses that produced the reverse faults, while other seem to be randomly oriented and are possibly related to diagenesis of strata in the Selma Group and underlying formations.

MULTISTAGE FAULTING AT MOSCOW LANDING

A sequence of folded and faulted Upper Cretaceous and Paleocene strata is exposed in southeastern Sumter County in bluffs on the right bank of the Tombigbee River in the vicinity of Moscow Landing (plate 1). The exposure is virtually continuous from the Demopolis Rooster Bridge southwest to the mouth of the Sucarnoochee River, a distance of one mi (1.6 km). The presence of distinct lithologies, prominent unconformities and vertically limited faunal zones facilitate the recognition and interpretation of structural features exposed in the bluffs.

Previous investigators have considered the faults exposed at Moscow Landing to be the result of a single event of either post-Porters Creek (Smith, 1910) or post-Prairie Bluff - pre-Clayton age (Brett and Jones, 1967). While Brett and Jones consider these faults to be the eastern extension of the Livingston fault zone, Monroe (1941) and Newton, Sutcliffe, and LaMoreaux (1961) extend the Livingston fault zone across the Tombigbee River into Marengo County some 5 mi (7.4 km) northeast of Moscow Landing.

The oldest faults exposed at Moscow Landing are characterized by a zone of plastic flow 4 to 40 in (10.1 to 101.6 cm) thick (fig. 4A). They displace only the Prairie Bluff Chalk and are truncated by the Cretaceous-Tertiary unconformity. These faults therefore formed shortly after deposition of the Prairie Bluff Chalk and prior to deposition of the Clayton Formation.



A

B

Figure 4.—Multistage faulting exposed in the right bank of the Tombigbee River at Moscow Landing, sec. 25, T. 17 N., R. 1 W., Sumter County. A: Post-Prairie Bluff – pre-Clayton normal fault truncated by Cretaceous-Tertiary unconformity. B: Post-Porters Creek fault. Tc: Clayton Formation; Tpc: Porters Creek Formation; Kpb: Prairie Bluff Formation.

The fault shown in figure 4A (and section D-E of pl. 1) is representative of the post-Prairie Bluff - pre-Clayton faults exposed at Moscow Landing. This fault is normal, downthrown to the northeast. The fault plane strikes N 75° W and dips 35° NE. Displacement is over 9 ft (3.0 m). The zone of plastic flow that marks the fault zone is 3 ft (1.0 m) in width, contains undeformed fossil molds and casts, and is truncated by the Cretaceous-Tertiary unconformity.

An intermediate stage of faulting is represented by a single fault that displaces the Prairie Bluff Chalk and dies in the basal sandstone of the Clayton Formation (sec. C-D, pl. 1). This fault is normal with up to 4 in (10 cm) of displacement. The fault plane strikes E-W, dips 65° N, and is marked by a thin sheet of calcite which preserves slickensides.

The youngest faults are characterized by slickensided calcite-filled fractures. These faults displace all exposed formations and are thus considered to be post-Porters Creek in age (fig. 4). Like the faults of the Livingston fault zone to the north and peripheral fault zones to the south, these late stage faults frequently produce narrow horsts and grabens which apparently parallel regional strike (sec. E-F, pl. 1).

The graben in section G-H of plate 1 is bounded by two normal faults having relatively large displacements. The southwestern fault juxtaposes the clay in the upper part of the exposure of Porters Creek against the basal sandstone of the Clayton Formation. Minimum displacement is thus 21 ft (6.4 m). Displacement on the northeastern fault is somewhat less. An interesting feature of this graben is the minor dip reversal exhibited by beds on either side.

The post-Porters Creek faults are usually marked by veins of slickensided calcite, however, the fault planes within the Porters Creek lithology may be marked by a zone of limonite and selenite. In at least one place, an apparent major post-Porters Creek fault is marked by the presence of a breccia zone some 16 ft (5.0 m) in width. This breccia is composed of subrounded to angular boulders up to 2 ft (0.7 m) in diameter that are composed of lower Porters Creek lithology and enclosed in a fine-grained structureless matrix.

The faults have not been traced away from the bluffs at Moscow Landing; however, a series of normal faults displacing the Cretaceous-Tertiary unconformity are exposed at Old Canton Landing on the Alabama River in Wilcox County (Stephenson, 1915). The apparent similarities between the exposures at Moscow and Old Canton Landing are striking, however, their relationship, if any, is unknown. The relationship of the faults at Moscow and Old Canton Landing to

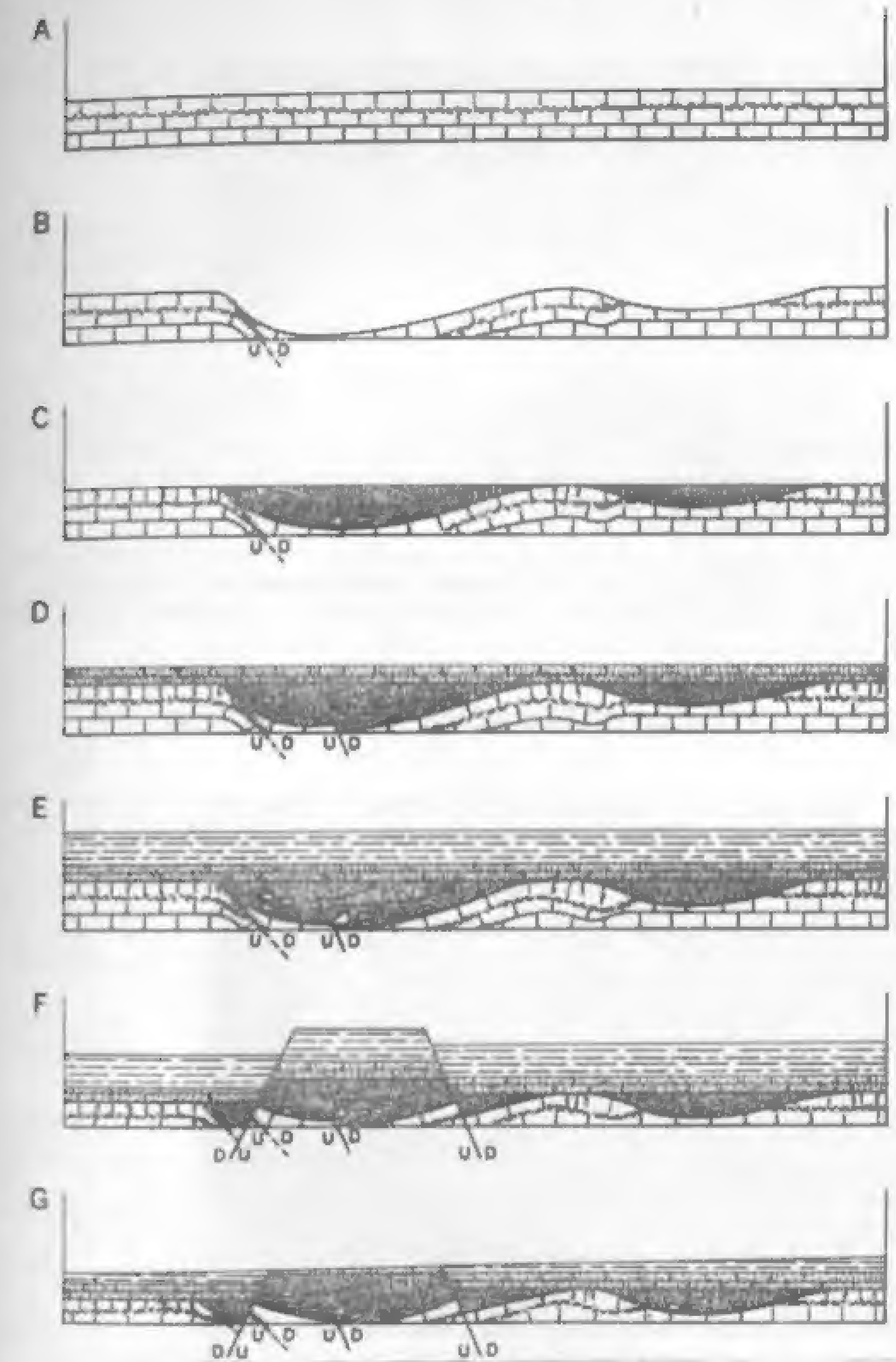


Figure 5.--Deformational history of the Moscow Landing exposure. A: Deposition of Prairie Bluff. B: Post-Prairie Bluff - pre-Clayton faulting. C: Deposition of lower Clayton. D: Deposition of lower Clayton. D: Deposition of upper Clayton and intermediate faulting. E: Deposition of Porters Creek. F: Porters Creek faulting. G: Erosion to present topography.

the Livingston fault zone is also unresolved as is the ultimate age of the last movement on the post-Porters Creek faults. The relative chronology of the [illegible] deformation at Moscow Landing has, however, been established (fig. 5).

Prior to lithification of the Prairie Bluff Chalk, probably during the latest Cretaceous, the Moscow Landing area was subjected to [illegible] tensional [illegible] which resulted in the formation of low [illegible] normal faults (fig. 5A-B).

During or shortly after the deposition of the [illegible] sandstone of the Clayton Formation, a second [illegible] faulting occurred (fig. [illegible]). The [illegible] of this episode exhibit many of the [illegible] of the later post-Porters Creek faults.

Following deposition of the Porters Creek Formation, the Moscow Landing area was again subjected to tensional forces which resulted in a third episode of normal faulting (fig. 5I).

NORMAL FAULTS IN THE DEMOPOLIS CHALK

Normal and unresolved (normal ?) faults occur northeast of the Livingston fault zone in the outcrop of the Demopolis Chalk. These faults are [illegible] distributed and exhibit no preferred orientation. The fault [illegible] are marked by either slickensided calcite [illegible] or clay gouge [illegible]. [illegible] faults are related to the gentle folding [illegible] of the Demopolis Chalk [illegible]. However, a number of these faults can be observed [illegible] toward the axis of an apparent monocline. Other faults of this type may be related to [illegible] of the [illegible].

The faults are generally curved (scalloped) in both plan and section views. Intersections of these faults are common and are generally [illegible] Y-shaped (fig. 6). As in the case of the calcite-filled faults in the Livingston fault zone, multiple displacements are indicated by the presence of several slickensided surfaces occurring within a single fault plane. The calcite fillings weather more slowly than the enclosing chalk and are expressed as prominent ridges on weathered horizontal chalk exposures (fig. 7).

Displacement of these normal faults is generally small. The largest vertical displacement probably does not exceed 25 ft (7.6 m), most are less than 3 ft (1.[illegible] m).

Figure 6.--"Y"-shaped triple junction of calcite-filled normal faults in the Demopolis Chalk. Two normal faults on quarry wall are approximately on strike with the rear fault triple junction. Note "scalloped" pattern of the trace of this fault. North wall of the Citadel Cement Corp. in sec. 20, T. 18 N., R. 3 E., Marengo County, Alabama.

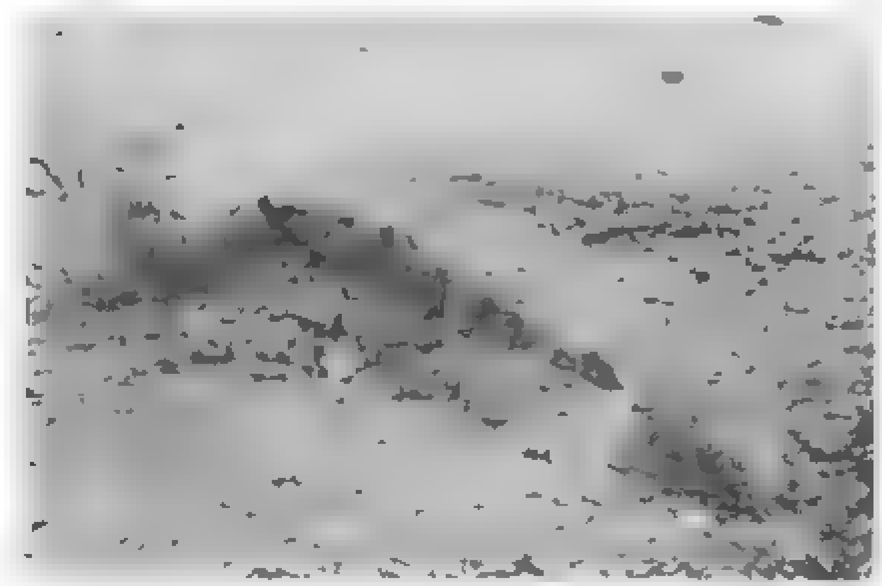


Figure 7.--Slickensided calcite filling weathering to a prominent ridge, sec. 3, T. 18 N., R. 2 E., Sumter County, Alabama.

These faults displace only strata of the Demopolis Chalk and near the Tombigbee and Alabama Rivers are overlain by undeformed Quaternary low terrace deposits. There are numerous faults exposed on bald spots and in road cuts which can be dated only as post-Demopolis. No upper limit for the time of formation can be given until an acceptable technique for dating the slickensided calcite fillings is discovered.

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FAULTS IN TERTIARY ROCKS OF SOUTHWESTERN ALABAMA[2]

By Charles W. Copeland[1]

INTRODUCTION

In Alabama, the Tertiary formations range in age from Paleocene to Pliocene and con[illegible] predominantly of marine clastics, and are transitional in character between the clastic and largely [illegible] formations of Mississippi and the carbonate rocks of the Florida peninsula. [illegible] the formations strike northwestward and dip southwestward [illegible] 4 to 5 feet (ft) per mile (mi) or [illegible] meter (m) per kilometer (km) except in areas where folding and faulting occur. Dip of the Neogene and Quaternary units is somewhat less and generally ranges from [illegible] ft [illegible] mi [illegible] to 50 ft/mi [illegible] m/km). The formations of Tertiary age reach a maximum thickness of about 5,[illegible] ft ([illegible] m) near the coast with the greatest thickening occurring in the Miocene Series. Miocene fluvial [illegible] fine and coarse clastic [illegible] marine [illegible] coast.

The major structural features exposed in southwest Alabama are the Hatchetigbee anticline and the [illegible], West Bend, Coffeeville, Jackson and [illegible] fault [illegible]. The Pollard fault system in [illegible] County is an apparent continuation of the Coffeeville and West Bend fault [illegible], but is masked at the surface by fluvial sediments, mainly of Miocene and Pliocene age.

In addition to the major faults, numerous minor faults (those of less than 100 ft ([illegible] m) vertical displacement) occur in southwestern Alabama and [illegible] identified [illegible] each county, by the first three letters of the county name followed by an assigned number. Details of selected faults are presented in an appendix included at the end of this report. The locations of faults and descriptions of the stratigraphy are based in part on field examinations and in part are taken from the published county geologic maps of the area. Names, dates and authors of the county geologic maps are included in the list of references.

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[1] From Copeland, C. W., 1976, Report prepared in cooperation with U.S. Geological Survey under Research Grant No. 14-08-0001-G-145.

[2] Geological Survey of Alabama, publication approved by the Acting State Geologist.

STRATIGRAPHY OF TERTIARY FORMATIONS

Paleocene Series (Midway Group)

Clayton Formation

The Clayton Formation, named for exposures in a railroad cut [illegible] of Clayton, Barbour County, Alabama, rests unconformably on the rocks of the Cretaceous System. This disconformity represents a relatively long lapse of time, as is indicated by the great faunal change. The contact is marked by a basal conglomerate or basal sand with large glauconite grains and reworked Cretaceous fossils. The basal bed ranges in thickness from an inch to [illegible] ft ([illegible] cm to less than 1 m). Where it is thin, the contact is obscure because of the similar color and lithology of the chalky beds above and below it. Argillaceous beds above the basal sand contain the lower Paleocene guide fossil [illegible] Harris. From Sumter County eastward to [illegible] County, the Clayton is overlain conformably by the Porters Creek Formation. In [illegible] and [illegible] the upper surface of the formation is deeply weathered and the Clayton is overlain disconformably by the Nanafalia Formation of lower Eocene age.

In western Alabama the Clayton Formation, consisting of chalky marl and limestone, is 5 to 20 ft ([illegible] m) thick, but in Wilcox County it thickens to [illegible] ft ([illegible] m). In Wilcox and [illegible] Counties it is divided into two members, the Pine Barren Member below, consisting of interbedding [illegible] layers of gray to white calcareous micaceous micro-[illegible] calcareous silt with [illegible] sand and [illegible] limestone at the top, and the McBryde Limestone Member above, consisting of light-gray massive [illegible] glauconitic chalk or granular limestone (fig. [illegible]).

Porters Creek Formation

The Porters Creek Formation overlies the Clayton and is named for exposures on Porters Creek, Hardeman County, Tennessee. In western Alabama the Porters Creek Formation consists of 450 ft (137 m) of dark-brown to black [illegible] massive clay that breaks with a subconchoidal fracture, and about 15 ft (5 m) of glauconitic [illegible] marl (Matthews Landing Marl Member) at the top. The clay [illegible] and forms tough clay soil of the "Flatwoods" belt that is well developed in Mississippi and extends eastward into Alabama as far as the Alabama River [illegible] Midway [illegible]. [illegible] thins and becomes increasingly calcareous east of the Alabama River. The Matthews Landing Marl Member [illegible]

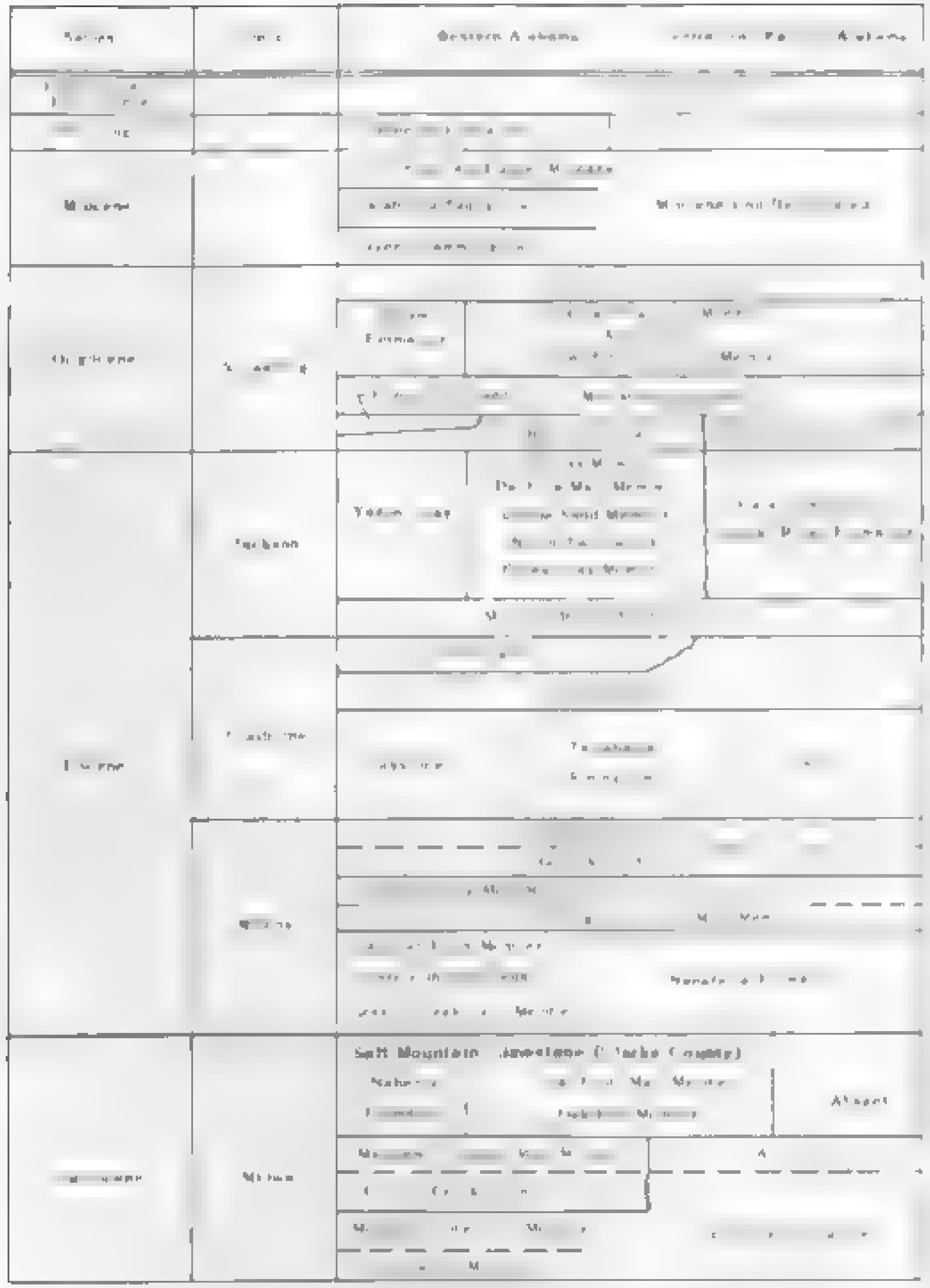

Figure 8.--Outcropping Tertiary formations of South Alabama.

top, about 15 ft (5 m) thick, consists chiefly of brownish-gray calcareous silty clay and light-gray glauconitic sand and marl containing many species of mollusks. The total thickness of the Porters Creek Formation in Wilcox and Butler Counties is about 150 ft (46 m). In Crenshaw County, a prominent limestone is present in middle and upper part of the formation. East of Crenshaw County, beds correlative with the Porters Creek, if present, are included in the Clayton Formation because of similar lithologies.

Naheola Formation

The Naheola Formation was named from exposures at Naheola Landing, a settlement on the Tombigbee River in Choctaw County. It was first described by Smith (1886) under the heading "Naheola and Matthews Landing section." The type locality is a bluff on the Tombigbee River in the SE¼ sec. 30, T. 15 N., R. 1 E.

The Naheola Formation is divided into the Oak Hill Member below and the Coal Bluff Marl Member above (fig. 8). The Oak Hill Member was named from exposures in road cuts near Oak Hill Post Office, Wilcox County, Alabama (Toulmin, LaMoreaux and Lanphere, 1951). The Coal Bluff Marl Member is named for exposures at Coal Bluff on the right bank of the Alabama River in the SE¼ sec. 7, T. 11 N., R. 7 E., Wilcox County (LaMoreaux and Toulmin, 1959).

The Oak Hill Member, consisting of brown thin-bedded carbonaceous silt and silty clay and beds of greenish-gray fine-grained sand, generally is 60 to 100 ft (18 to 30 m) thick in western Alabama. Lignite, ranging in thickness from 1 to 7 ft (0.3 to 2 m), is present in places at the top of the member.

The Coal Bluff Marl Member, consisting of glauconitic fossiliferous sandy marl with thin-bedded silty clay in the upper part, is variable in thickness. The thickness in west-central Alabama generally ranges from 15 to 30 ft (5 to 9 m). The member thins eastward and east of Wilcox County, where present, is included in the Porters Creek Formation because of its thinness and similarity with underlying beds.

Salt Mountain Limestone

The Salt Mountain Limestone is exposed only in the vicinity of the type locality at Salt Mountain about 7 mi south of Jackson, Alabama. The formation is approximately 90 ft (27 m) thick at the type locality and consists of white crystalline fossiliferous limestone from which boulders 2 to 8 ft (0.6 to 2.4 m) thick, and other masses of soft white limestone (Toulmin, 1940, p. 3).

formation contains Odontogryphaea thirsae (Gabb), a distinctive fossil considered by many [illegible] restricted to the Nanafalia Formation of Eocene age in the outcrop area to the north. The Salt Mountain Limestone, previously considered to be Eocene in age is now included in the Paleocene on the basis of its planktonic foraminifera [illegible] and Tarpan, [illegible], p. [illegible]). Correlations established by [illegible] and [illegible] ([illegible], p. [illegible]) indicate that the Salt Mountain is younger than the Naheola Formation and older than the Nanafalia Formation. The Salt Mountain, except where exposed along the downthrown side of the [illegible] fault, is confined to the subsurface and is overlain [illegible].

Eocene Series

Lower Eocene Formations (Wilcox Group [illegible])

Nanafalia Formation

The Nanafalia Formation is named for exposures at Nanafalia Landing on the Tombigbee River, [illegible] County, Alabama. In Alabama the Nanafalia Formation is divided into three members. The Gravel Creek Sand Member at the base consists of [illegible] coarse-grained crossbedded [illegible] sand containing [illegible] quartz gravel and [illegible] clay. It rests disconformably on the upper member of the [illegible] Formation. The member [illegible] and pinches out downdip. The middle unnamed member of the Nanafalia consists of glauconitic [illegible] sand and glauconitic sandy marl filled with the [illegible] fossil, Odontogryphaea thirsae (Gabb). Because of their abundance, the [illegible] is often referred to as the "[illegible]." The upper [illegible] Member [illegible] glauconitic [illegible] clay and [illegible] with glauconitic sand beds in places [illegible] numerous [illegible] and is named for exposures in the [illegible] in Wilcox County. The formation [illegible] in thickness from [illegible] to [illegible] ft ([illegible] m) in south-central and southwestern Alabama and thins eastward.

Tuscahoma Sand

The Tuscahoma Sand is named from exposures at Tuscahoma Landing on the Tombigbee River in the [illegible] sec. 31, T. 13 N., R. 1 W., Choctaw County, Alabama. Smith and Johnson (1887) first called it the "Bells Landing series" from exposures at that landing on the Alabama River in Monroe County, and later Smith, Johnson, and Langdon ([illegible]) called it the "Tuscahoma or Bells Landing series." The formation

includes the Greggs Landing Marl Member, 6 ft (2 m) thick at the type locality on the right bank of the Alabama River in northern Monroe County between Lower Peach Tree and Bells Landing, and the Bells Landing Marl Member, 6 to 10 ft (2 to 3 m) thick at the type locality on the left bank of the Alabama River downstream a short distance from the type locality of the Greggs Landing Marl Member. The two marl beds were named by Smith (1883). The top of the Greggs is [illegible] ft ([illegible] m) below the bottom of the Bells Landing. The Bells Landing is near the middle of the Tuscahoma Sand and is about [illegible] ft ([illegible] m) below the Bashi Marl Member at the base of the Hatchetigbee Formation.

The Tuscahoma Sand has about the same lithologic character from western to eastern Alabama. The formation ranges in thickness from about 250 to 350 ft (76 to 107 m) in western Alabama and thins eastward from Butler County to about [illegible] ft ([illegible] m) in the outcrop in Henry County (Newton, [illegible]). The Bells Landing Marl Member is not distinguishable in the eastern part of the State (LaMoreaux and Toulmin, 1959).

The Tuscahoma consists chiefly of nonfossiliferous gray interlaminated fine-grained sand and clayey silt containing three or more fossiliferous glauconitic sand and marl zones in the lower half of the formation (Toulmin, 1955). The fossiliferous beds of the Tuscahoma Sand (Bells and Greggs Landing Marl Members) are characterized by [illegible].

Hatchetigbee Formation

The Hatchetigbee Formation was named from Hatchetigbee Bluff on the Tombigbee River in sec. [illegible], T. 13 N., R. [illegible] W., Washington County (Smith, 1886). The Bashi Marl Member at the base of the formation was named for exposures along Bashi Creek, which flows into the Tombigbee River in the [illegible] sec. [illegible], T. [illegible] N., R. 1 W., Clarke County (Heilprin, 1882; Smith, 1886).

The Hatchetigbee Formation resembles the Tuscahoma lithologically, and is separated from it by the Bashi Marl Member of the Hatchetigbee, a fossiliferous glauconitic calcareous sand in which large spheroidal concretions occur. The Bashi is prominent in outcrops, is easily traced across the State, and is a good zone for mapping structure. The Bashi Member generally ranges in thickness from 6 to [illegible] ft (2 to [illegible] m) in south Alabama. The Hatchetigbee generally ranges in thickness from 25 ft (8 m) in Butler County to [illegible] ft ([illegible] m) in Choctaw County, and except for the Bashi Member does not extend east of Butler County.

Middle Eocene Formations (Claiborne Group)

Tallahatta Formation

The Tallahatta Formation is named from the Tallahatta Hills which extend northwestward across the [illegible] of Choctaw County. The name was first used by [illegible] to whom it was suggested by E. A. Smith as a replacement of the lithologic term "[illegible]."

The Tallahatta Formation rests disconformably on the Hatchetigbee Formation. [illegible] is separated in [illegible] from the [illegible] by [illegible] of the Meridian Sand [illegible] Alabama. The [illegible] marine siliceous claystone [illegible] sand and sandstone. [illegible] "buhrstone" in [illegible] prominent northward-[illegible] into a range [illegible] from the vicinity of Meridian, [illegible] Choctaw County [illegible] Alabama. An upward-[illegible] of the Hatchetigbee [illegible] Choctaw County. [illegible] conitic [illegible] formation are very [illegible] beds of the [illegible] Eocene Series [illegible] exposed in Little Stave Creek [illegible] Clarke County, Alabama. In the outcrop, the Tallahatta is [illegible] ft ([illegible] to 38 m) thick in [illegible] Alabama.

East of Clarke County, the middle and upper part of the formation become [illegible] thicken and become more [illegible] Alabama the formation [illegible] There, in the west [illegible] consist almost entirely of [illegible] the state, [illegible] bottom [illegible] top of the formation.

Lisbon Formation

The middle Eocene of Alabama has been the subject of many geological investigations [illegible] with [illegible] and [illegible]. Aldrich ([illegible]) first used the term Lisbon [illegible] a part of the presently recognized [illegible] Formation. [illegible] ([illegible]) used the name [illegible] in his description of Claiborne and Lisbon Bluff on the Alabama River. The Lisbon Formation in western Alabama is the sequence of strata bounded by the Tallahatta Formation below and the Gosport Sand above. The formation is named for Lisbon Bluff on the right bank of the Alabama River, Clarke County, Alabama.

The Lisbon Formation in south Alabama consists chiefly of marine calcareous glauconitic sand, marl, and sandy clay and is more or less fossiliferous throughout. It interfingers westward in western Choctaw County with some nonmarine beds and in that area can be divided into units recognized in Mississippi. In western Choctaw County the formation is about 250 ft (76 m) thick and from bottom to top it consists of glauconitic sand, brown carbonaceous clay and sandy clay, crossbedded sand, and fossiliferous glauconitic marl and nonfossiliferous clay. The formation becomes thinner eastward and downdip and is about 165 ft (50 m) thick in the area north of the Hatchetigbee anticline in eastern Choctaw County, from 100 to 125 ft (30 to 38 m) thick south of the Hatchetigbee anticline in Choctaw and Washington Counties, about 125 to 150 ft (38 to 46 m) thick in western and central Clarke County, 117 ft (36 m) thick on the Alabama River, and 75 ft (23 m) thick on the Conecuh River (Oman, 1965). Several beds in the formation contain the large Cubitostrea sellaeformis (Conrad), and Cubitostrea lisbonensis (Harris) is common in the lower beds. In central Alabama the formation thins and consists almost entirely of deeply weathered sand in the outcrop.

Gosport Sand

The Gosport Sand named for Gosport Landing on the Alabama River, Clarke County, Alabama is separated from the Lisbon Formation by a minor disconformity. The formation consists of fine- to coarse-grained glauconitic very fossiliferous sand and interfingering wedges of carbonaceous shale. The formation is 17 ft (5 m) thick on the Alabama River at the famous Claiborne Bluff exposure, but it thickens westward to about 30 ft (9 m) in central Choctaw County where it consists chiefly of yellow to orange highly crossbedded glauconitic sand and brown carbonaceous shale. Fossiliferous beds become thin and inconspicuous in western Alabama. The Gosport Sand is not readily recognizable east of the Alabama River.

Upper Eocene Formations (Jackson Group)

Moodys Branch Formation

The Moodys Branch Formation is named for exposures along Moodys Branch of Pearl River in Jackson, Mississippi. In west Alabama, the Moodys Branch Formation is separated from the Gosport sand by an inconspicuous disconformity marked by phosphorite pebbles and large glauconite grains. It consists of greenish-gray fossiliferous calcareous glauconitic sand and sandy marl 10 to 20 ft (3 to 6 m) thick. Some beds contain numerous specimens of the guide fossil Periarchus lyelli (Conrad).

Red Bluff Clay

The Red Bluff Clay named for exposures at Red Bluff on Chickasawhay River, Wayne County, Mississippi, extends from Mississippi into western Alabama. Toward the east it becomes considerably thinner and more calcareous. In southwestern Choctaw County the formation is about 60 ft (18 m) thick and consists of yellow glauconitic limestone containing Alectryonia vicksburgensis (Conrad) and [illegible] (Morton) overlain by greenish-gray glauconitic [illegible] clay and by gray silty nonfossiliferous clay with thin beds of sand. In Little Stave Creek the upper clay is absent and the lower glauconitic marl grades into [illegible] glauconitic chalky limestone. The formation varies greatly in thickness and is 60 ft (18 m) thick in southwestern Choctaw County and western Clarke County, [illegible] thick at St. Stephens Bluff, Washington County, and ranges from 5 to 10 ft (1.5 to 3 m) thick in eastern Clarke County and in Monroe County.

In eastern Clarke County and in Monroe County the formation becomes more calcareous and is mainly sandy glauconitic fossiliferous marl and limestone, with a limestone equivalent. The term "[illegible]" was proposed by [illegible] (19[illegible]) as a new stratigraphic name in Alabama for Red Bluff equivalent limestones in south-central parts of the State.

Marianna Limestone

The Marianna Limestone named for exposures at Marianna, Jackson County, Florida, consists of white to cream-colored soft porous chalky fossiliferous limestone. The formation also includes glauconitic limestone and calcareous sand in the bottom part in western Alabama. The Marianna Limestone in west Alabama has an estimated thickness of 20 to 80 ft (6 to 24 m). The formation contains the guide fossils Lepidocyclina mantelli (Morton), Clypeaster rogersi (Morton), and Pecten [illegible] (Morton).

Byram Formation

The Byram Formation, named for exposures on the Pearl River at Byram, Hinds County, Mississippi, includes, from the bottom up, yellow to white irregularly indurated coquinoidal and crystalline limestone (Glendon Limestone Member), gray to tan sandy glauconitic fossiliferous marl (unnamed marl member), and yellow sand and dark bentonitic carbonaceous clay (Bucatunna Clay Member). The Glendon Limestone can be differentiated from the Marianna Limestone on which it lies conformably by its lithologic characteristics and fauna. Where both formations are exposed, the Glendon is harder and in most

places forms an overhanging ledge penetrated by numerous irregular tubular solution cavities. The Glendon contains Pecten perplanus byramensis (Gardner). The Glendon is about 20 ft (6 m) thick at the type locality, Glendon Station, in Clarke County, Alabama. In a quarry at St. Stephens in Washington County, south of the Hatchetigbee anticline, the Byram Formation is 39 ft (12 m) thick. The Byram in Clarke and Monroe Counties ranges in thickness from 70 to 90 ft (21 to 27 m) mainly due to increased thicknesses of the Bucatunna Clay Member.

Chickasawhay Limestone

The Chickasawhay Limestone consists of bluish-gray glauconitic soft marl and harder beds of white limestone. The formation is named for exposures on the Chickasawhay River, Wayne County, Mississippi. The formation carries Kuphus incrassatus Gabb (Teredo circula Aldrich), a large calcareous tube of a boring mollusk that is diagnostic of the Chickasawhay Limestone and equivalent beds. About 20 ft (6 m) of the formation is exposed in the quarry at St. Stephens in Washington County. The Chickasawhay is rarely exposed in Clarke County. Where exposed, it generally consists of less than 10 ft (3 m) of yellow clayey marl, light-gray to yellowish-gray hard crystalline fossiliferous limestone, and fossiliferous sandy marl. The formation in Monroe County is not well exposed, ranges in thickness from 1 to 25 ft (0.3 to 8 m), and is yellowish-orange to yellowish-brown sandy fossiliferous limestone. The unit is overlapped by the Miocene Series in Monroe County and is absent in most outcrops of Oligocene beds.

Miocene Series

The Miocene Series includes from the bottom up, the Paynes Hammock Sand consisting of light colored sand and gray clay with some beds of fossiliferous marl, the Catahoula Sandstone consisting of grayish-yellow sand and gray clay, and undifferentiated overlying strata.

The Paynes Hammock Sand was named by MacNeil (1944) from an exposure along the Jackson fault at Paynes Hammock on the Tombigbee River, in the SW¼ sec. 16, T. 5 N., R. 2 E., Clarke County, Alabama. At the type locality the formation is about 13 ft (4 m) thick and consists of greenish-blue clayey sand, greenish-blue fossiliferous clay and one indurated limestone ledge. Outcrops of the Paynes Hammock are extremely rare and the unit is not mappable. According to MacNeil (1944) no good exposures that show the complete upward transition from the fossiliferous Paynes Hammock Sand to the nonfossiliferous beds lithologically typical of the Catahoula are known between Wayne County, Mississippi and Florida.

The Miocene Series across south Alabama is mapped as an undifferentiated unit. Surface exposures consist of deeply weathered red and orange sands, thin gravel beds and massive mottled vari-colored clays. The Miocene Series ranges in thickness from a feather edge updip to more than 2,000 ft (610 m) in south Mobile and Baldwin Counties.

Pliocene Series

Citronelle Formation

The Citronelle Formation was named by Matson (1916) for exposures around Citronelle in Mobile County, Alabama. In Alabama the formation is best exposed in Mobile, Baldwin, and Escambia Counties and is widely distributed as outliers or as a veneer over older formations beyond these limits, especially in Monroe, Conecuh, and Washington Counties (Cooke, 1926). The formation ranges in thickness from around 100 ft (30 m) in updip areas to 200 ft (61 m) near the mouth of the Mobile Bay. The formation consists of deeply weathered red sands which contain quartz and chert pebbles and lenticular beds of red, purple, yellow and gray clays which typically are mottled in appearance.

The Citronelle is difficult to map and is easily confused with the underlying Miocene deposits and terrace deposits which occur along the major streams.

STRATIGRAPHY OF QUATERNARY DEPOSITS

Pleistocene and Holocene Series

Terrace Deposits

Terrace remnants unconformably overlie older geologic units throughout southern Alabama and generally occur in areas adjacent to major streams and their larger tributaries. The terraces which probably range in age from Pleistocene to Holocene represent ancient flood plains of major streams that were abandoned when the streams entrenched to lower elevations. The deposits generally are less than 60 ft (18 m) thick and consist chiefly of deeply weathered, reddish-orange lenses of sandy gravel, poorly sorted crossbedded sands, clay, and silt. The gravel consists mainly of well rounded quartz, usually less than 1 in (2.54 centimeters [cm]) in diameter.

The slopes of the terrace surfaces are generally south toward the Gulf of Mexico and the deposits have been mapped in south Alabama at elevations ranging between 20 and 575 ft (6 and 175 m) above sea level. Near the coast in southern Baldwin and Mobile Counties, the terraces merge with coastal deposits.

Correlation studies of the terraces have not been made, however, a regional study of these features when detailed topographic mapping is available will provide a better understanding of the past history of the present streams.

Alluvial Deposits

Alluvial deposits of Holocene age underlie the floodplains of all the major streams in south Alabama and unconformably overlie units of older geologic age. The alluvial deposits generally consist of mixtures of sand, clay, and gravel in varying amounts. Information concerning the thickness of these deposits is not readily available, but in general, accumulations of alluvial materials are thickest where the stream gradient and corresponding load carrying capacity is decreasing.

In Mobile and Baldwin Counties, Alabama, the alluvial deposits are generally less than 70 ft (21 m) thick except in the Mobile River floodplain where they are as much as 150 ft (46 m) thick. The deposits consist of white, gray, orange, and brown partly carbonaceous, locally fossiliferous, very fine to coarse-grained sand that is gravelly in many exposures.

SOUTHWEST ALABAMA FAULTS

Peripheral Fault Systems

The major peripheral faults in southwestern Alabama, the Gilbertown, Coffeeville-West Bend, Bethel and Pollard faults, form major regional partly en-echelon grabens about 4 mi (6.4 km) wide that dip both basinward and landward, being normal downthrown or upthrown respectively on the Gulfward (basin) side. The peripheral faults have been mapped in the subsurface as a nearly continuous trend extending from Choctaw County southeastward across Clarke County and the tip of Monroe County into Escambia County (Murray, 1961; Moore, 1971; Wilson and Kidd, 1975). Abnormal thicknesses of sediments within the grabens accompanied by an increase in displacement of the faults at depth support the views of Murray (1961) and Joiner and Moore (1968) that the peripheral faults have been active since late Paleozoic or early Mesozoic time.

The faults are parallel or subparallel to regional strike and all but the Pollard faults are mappable to some extent at the surface in southwestern Alabama. The faults occur near the updip limits of thick Jurassic carbonates and near the edges of the Mississippi interior salt basin. The peripheral fault system is thought by Murray (1961, p. 180) "to represent a belt of major fracturing associated with collapse of the Gulf of Mexico sedimentary basin."

Cloos (1968, p. 437) attributes the peripheral fault systems to gravity creep of the basin fill as follows:

> "The peripheral graben zone (Balcones-Mexia-Talco-South Arkansas-Pickens-Gilbertown) follows the "contact" between stationary margins of the Gulf Coast and the central area which creeps away from it. This resembles the familiar "Bergschrund" crevasse where a glacier pulls away from a mountain ice field. It is explained easily as that zone along which the creeping sediments are torn loose from the stationary area. This zone coincides in the Gulf Coast with the approximate [illegible] updip edge of the salt, thus suggesting that the salt may well facilitate the creep."

Joiner and Moore (1968, p. 31) in their discussion of south Alabama structural features place special emphasis on the importance of salt distribution and movement to structures and state that most of the geologic structures observable in Early Cretaceous or younger sediments in the Mississippi interior salt basin are the result of movement of the underlying Louann Salt (Jurassic).

Gilbertown Fault Zone

The Gilbertown fault zone in Choctaw County is about 4 mi (6.4 km) wide and at the surface deforms beds of Claiborne, Jackson, Vicksburg and Miocene-Quaternary age. Details of the individual faults are included in the appendix. The fault zone coincides with a topographic low with related drainage phenomena that suggests that movement along these faults has occurred in relatively recent times (Murray, 1961, p. 186). Surface traces of the faults in the Gilbertown area are difficult to map as are most of the major faults in the Coastal Plain and may be more numerous than shown on plate 2. The approximate traces of the faults are determined from the localized occurrences of discordant stratigraphic units. Vertical displacements at the surface range from 50 ft (15 m) to 130+ ft (40+ m) and increase at depth. At the horizon of the Eutaw Formation (Late Cretaceous) at depths between 3,500 ft (1,067 m) and 4,000 ft ([illegible] m) displacements range from 350 ft (107 m) to 900 ft (274 m) (Joiner

Figure 9.— Photograph of Choctaw County fault (Cho-5) on the west side of a county road 0.8 mi (1.3 km) north of Womack Hill in the NE¼ NW¼ SW¼ sec. 4, T. 10 N., R. 2 W. Clay and sand of the Lisbon Formation (right side of photo) on the upthrown side are in fault contact with gravelly sand of the Miocene or Quaternary and the Red Bluff Clay (left side of photo) on the downthrown side.

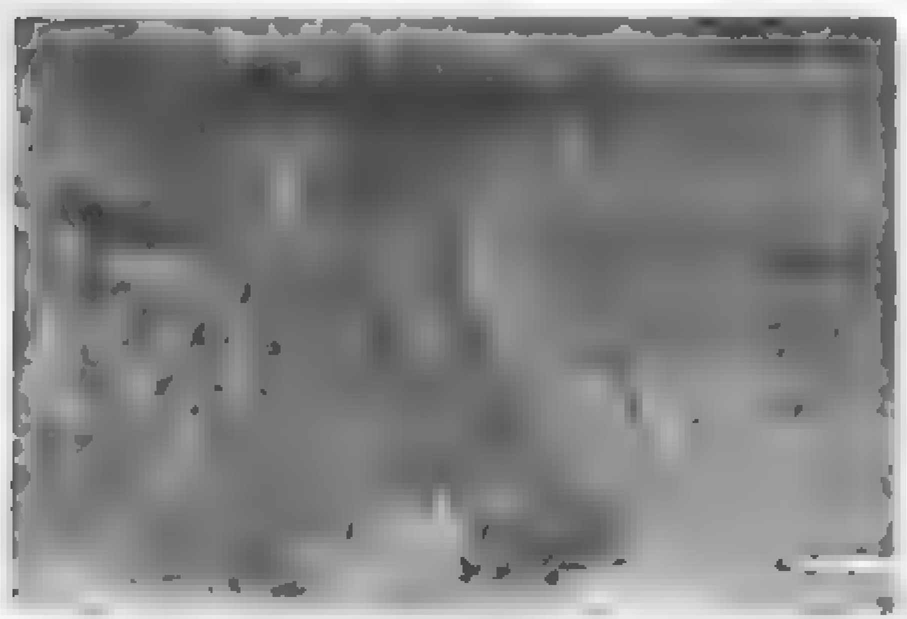

Figure 10.— Photograph of fault plane of Choctaw County fault (Cho-5) and collapse of Miocene or Quaternary sediments on the downthrown side. The Red Bluff Clay (Oligocene) is visible at the base of the roadcut in the left corner of the photograph.

The vertical displacements of the faults increase with depth. The subsurface structure map by Moore (1971, pl. 1) of the top of the "Lower Tuscaloosa" (Lower part of the Tuscaloosa Group—Late Cretaceous) and the maps of the top of the Smackover Formation (Jurassic) by Wilson and Kidd (1975) show that vertical displacements of faults in the Coffeeville-West Bend system range from 500 ft (152 m) to 1,500 ft (457 m). The subsurface configuration of faults mapped by Moore (1971) and Wilson and Kidd (1975) differ from the fault traces at the surface and the exact relationships are not known at this time.

Bethel Fault Zone

The Bethel fault in southwestern Wilcox County is a large normal fault downthrown to the southwest. As mapped by LaMoreaux and Toulmin (1960, pl. 2) the fault trends northwest-southeast for a distance of about 15 mi (24 km) from northwest of Pine Hill in the NW¼ sec. 20, T. 12 N., R. 5 E. to the SE¼ sec. 5, T. 10 N., R. 7 E. The Bethel fault is the most extensive of 4 mapped in the southwestern part of Wilcox County (pl. 2). The three faults in the northern part of the area are all downthrown to the southwest and the southernmost fault in the zone is downthrown to the west, north, and northeast and forms a graben in that part of Wilcox County that lies west of the Alabama River (pl. 2). Preserved within the graben are remnants of the Hatchetigbee Formation that is normally exposed at higher elevations from 5 to 10 mi (8 to 16 km) to the southwest and south of the fault zone. The Bethel and associated faults are known to only deform at the surface, formations of the Wilcox Group (Sabine Stage).

The Bethel fault juxtaposes the "Ostrea thirsae beds" of the Nanfalia Formation on the upthrown side with the Tuscahoma Sand on the downthrown side in an exposure on the Alabama River near Yellow Bluff Landing in the SE¼ sec. 17, T. 11 N., R. 6 E. Stratigraphic section missing because of the fault includes the Grampian Hills Member of the Nanafalia Formation (80 to 110 ft [24 to 33 m] thick) and an undetermined portion of the Tuscahoma Sand. The vertical displacement of the fault along the Alabama River is estimated to be 100 ft (30 m) or greater. A geologic section of beds exposed at the fault plane by LaMoreaux and Toulmin (1959, p. 208) shows no disruption of the bedding.

The other faults in the zone mainly juxtapose the Nanafalia Formation and the overlying Tuscahoma Sand. Displacements of the faults are probably 50 ft (15 m) or less. An absence of marker beds above the lower part of the Tuscahoma makes it difficult to make other than approximate estimates of vertical displacement. However, the southeast trending segment of the down to the northeast fault in the eastern half of sec. 10, T. 11 N., R. 5 E., juxtaposes the Nanafalia Formation on the upthrown side with the Hatchetigbee Formation on the downthrown side. A complete absence of

the Tuscahoma Sand indicates that in section 10, the fault has a minimum vertical displacement of 275 ft (84 m) based on the thickness estimates of the Tuscahoma Sand of LaMoreaux and Toulmin (1959, p. [illegible]). This southernmost fault in the Bethel zone is unusual in that elsewhere vertical displacements of the peripheral faults downthrown to the south exceed the displacements of peripheral faults downthrown to the north.

In the subsurface at the horizon of the "Lower Tuscaloosa" in the lower part of the Tuscaloosa Group (Late Cretaceous) at depths of from 2,[illegible] ft ([illegible] m) to 3,[illegible] ft ([illegible] m) below mean sea level, what are possibly the three southernmost faults of the Bethel zone have been mapped as a northeast-southeast trending graben (Moore, [illegible], p. [illegible]). Vertical displacement along the fault downthrown to the northeast ranges from [illegible] ft ([illegible] m) to 5[illegible] ft (1[illegible] m).

The Bethel fault zone is included in the peripheral fault system because it is located near the northern updip limit of the Mississippi interior salt basin. A deep oil test in sec. [illegible], T. [illegible] N., R. 5 E., penetrated salt at a depth of [illegible],1[illegible] ft ([illegible] m) below land surface.

Pollard Fault Zone

Faults of the Pollard fault zone are named for the community of Pollard in Escambia County and became known as a result of petroleum exploration activity in the vicinity. The zone extends from southeastern Clarke County, across the tip of Monroe County and into Escambia County where the trend for about [illegible] mi ([illegible] km) is nearly east-west. Below Pollard the faults curve [illegible] and are known to extend into Santa Rosa County, Florida (see [illegible] and others, 19[illegible], southwest quadrant of map of structural features of Alabama). The faults are known only from subsurface drill holes and are masked at the surface by a thick blanket of Miocene and Pliocene sediments.

The Pollard zone includes two large normal faults that form a graben characteristic of the peripheral fault system and the zone also includes several minor faults. The northernmost minor fault is downthrown to the south and southwest and at the horizon of the "Lower Tuscaloosa" in the lower part of the Tuscaloosa Group (Late Cretaceous) the vertical displacement is from 5[illegible] ft ([illegible] m) to [illegible] ft (183 m) (Moore, [illegible], p. [illegible]). The southernmost fault is downthrown to the north and northeast and the vertical displacement is from 200 ft (61 m) to 300 ft ([illegible] m).

At the horizon of the Smackover Formation (Jurassic) at depths of from 14,800 ft (4,512 m) to 16,100 ft (4,878 m) below mean sea level a single oil test well drilled in the graben indicates that vertical displacement of the faults increases with depth. The vertical offset inside the graben is about 1,100 ft (335 m)(Kidd and Wilson, 1975).

JACKSON-MOBILE GRABEN

Surface Investigation

The eastern shore of Mobile Bay, unlike the western shore, is steep and elevations of up to 120 ft (37 m) occur within 400 ft (122 m) of the shoreline as far south as Fairhope. The abrupt cliff paralleling the shoreline is a possible fault line scarp representing the eastern boundary fault of the Jackson-Mobile Graben of Murray (1961, p. 187 and fig. 4.1). Murray is of the opinion that late Quaternary sediments are displaced as suggested by the course of the Tombigbee-Alabama-Mobile River system and by the shape and extent of Mobile Bay. Elevations near shore on the western side of Mobile Bay generally range from 5 to 20 ft (1.5 to 6 m).

Subsurface information to confirm a fault on the eastern shore of Mobile Bay is not available and therefore field investigations of possible faulting were made at all places along the eastern shore that are accessible. Red Bluff with a maximum elevation of 120 ft (37 m) in irregular section 43, T. 5 S., R. 2 E., Baldwin County is the only place not heavily forested.

At Red Bluff no evidence of deformation can be observed and 100 ft (30 m) of undifferentiated Miocene sediments are exposed and are overlain unconformably by from 10 to 15 ft (3 to 4.6 m) of the Citronelle Formation of Pliocene age. The 30 ft (9 m) of Miocene at the base of the cliff are mainly thin beds of moderate yellow and pale purple clay and sand with a lense of cross-bedded sand. The thin beds of clay and sand are overlain by 40 ft (12 m) of cross-bedded gravelly sand. The gravels are very fine to medium rounded quartz pebbles. The upper 30 ft (9 m) of Miocene are very pale orange and pale yellowish-orange thin beds of sand and clay. The Citronelle at Red Bluff is deeply oxidized, moderate reddish-orange medium grained quartz sand with very fine gravels.

About 2.5 mi (4 km) south of Red Bluff, at Fairhope, Citronelle-Miocene contacts are either obscured by slumping of the Citronelle over the underlying Miocene or an unmapped fault or fold may exist. Massive clay, typical of the

A [illegible] on the north- [illegible] the Butler-Monroe County boundary in the [illegible] Sec. [illegible], T. 9 N., R. [illegible] E. is of [illegible] because it is an apparent thrust fault [illegible]. Reverse fault [illegible] previously known to occur in [illegible]

Figure 11.—Photographs of Choctaw County fault (Cho-8) on the west side of a county road in the NW¼ SW¼ sec. 33, T. 9 N., R. 2 W. The Tallahatta Formation is on the left (downthrown side) and the Hatchetigbee Formation is on the right (upthrown side). The hammer in the center of the photograph is in the fault plane.

Figure 12.—Photograph of Clarke County fault (Cla-6) on the east side of a county road in the SE¼ SE¼ sec. 19, T. 9 N., R. 1 E. The Moodys Branch Formation is on the left (downthrown side) and the Lisbon Formation is on the right (upthrown side).

The normal fault, downthrown to the northeast, near [illegible] Creek southeast of U.S. Highway 84 in Clarke County (Cla-6 on pl. [illegible]) in the SE¼ SE¼ sec. 19, T. 9 N., R. 1 E., exposes the Moodys Branch Formation (late Eocene) and the Lisbon Formation (middle Eocene). The Moodys Branch on the downthrown side consists mainly of highly weathered glauconitic sand and sandy marl. The Lisbon Formation on the upthrown side is composed mainly of clay, clayey sand and glauconitic sand (fig. 12).

During this investigation, highly inclined beds of the [illegible] Formation dipping [illegible] were located along a dirt road 1.7 mi (2.7 km) northwest of [illegible] Chapel in the NW¼ [illegible] sec. 16, T. [illegible] N., R. 7 E., Wilcox County. The highly inclined beds are among the most [illegible] in the Coastal Plain and indicate the presence of an unmapped fault of [illegible] displacement trending northwest-southeast. The [illegible] occur in a heavily wooded area with few roads and it has not been possible to extend the fault beyond the single outcrop.

SALT SEEPS AND SPRINGS

Salt seeps occur as apparent fault related phenomena at four [illegible], near the Jackson fault, and near the [illegible] end of the [illegible] line (Hopkins, [illegible], and Barksdale, [illegible]). During the Civil War salt was produced at three of these localities, known as: the Lower Salt Works in sections [illegible] and [illegible], T. 5 N., R. 2 E., [illegible] mi ([illegible] km) south of Jackson in Clarke County; at the Central Salt Works in [illegible], T. [illegible], R. [illegible] E., 6 mi ([illegible] km) south of Jackson in Clarke County; and at the Upper Salt Works in sections 26, [illegible], and [illegible], T. 7 N., R. [illegible] E., [illegible] mi (6 km) northwest of Jackson in Clarke County. The [illegible] area, which was not worked, was principally located [illegible] the [illegible] Creek, within [illegible] of the [illegible] River [illegible] T. 7 N., R. [illegible], Washington County (pl. [illegible]).

The [illegible] Creek [illegible] occur on the southwestern limb of the Hatchetigbee anticline and near an inferred fault of minor displacement (Wa-[illegible]). The [illegible] at the Upper Salt Works occur along the crest of the Hatchetigbee anticline [illegible] faults of minor displacement (Cla-[illegible] and Cla-[illegible]). [illegible] seeps and springs at the Central and Lower Salt Works are located in the immediate vicinity of the Jackson fault which has an estimated minimum displacement of 1,550 ft [illegible].

Brine for the production of salt was obtained from springs and shallow wells. Wooden casings of the brine wells are still present at the [illegible] salt works but all other equipment has been removed. The brines ranged from about [illegible],000 to 45,000 parts per million sodium chloride.

The springs and wells at the various localities are in the outcrop of formations of the Wilcox or Claiborne Groups but the brine is believed to be derived from lower formations of Cretaceous and Jurassic age. The brine probably reaches the surface through openings formed as a result of displacements which produced the Hatchetigbee anticline and [illegible] fault.

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APPENDIX: FAULTS IN TERTIARY ROCKS IN SOUTHWESTERN ALABAMA

FAULT DATA

North Highway 17 fault — Choctaw County - 1

Trend: NE-SW (N. 73° E.) for a distance of 0.8 mi (1.3 km) from near NE cor. NW¼ [illegible] sec. 3, T. 15 N., R. 2 W., to near the NW cor. SW¼SW¼ sec. 3, T. 15 N., R. 2 W.

Age: Paleocene or younger

Type: Normal, dip is northwest

Displacement: Fault displacement is about [illegible] ft ([illegible] m). [illegible] in the [illegible] Member of the [illegible] Formation, where the fault crosses Alabama Highway 17 in [illegible] sec. [illegible], T. 15 N., R. 2 W. [illegible] 5 ft [illegible]. The elevation of the lignite bed 0.[illegible] mi ([illegible] km) south of the fault [illegible] 1[illegible] ft ([illegible] m). The trend of the fault [illegible] parallel to a tributary stream of [illegible] Creek.

References:

[illegible], L. [illegible] and LaMoreaux, [illegible] E., [illegible]5, Profile [illegible] Highway 17, Choctaw County, Alabama: Alabama Geol. Survey Spec. Map [illegible].

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[illegible], [illegible], [illegible], Geologic map of Choctaw County, Alabama: Alabama Geol. Survey Map [illegible].

[illegible] fault [illegible] — Choctaw County - [illegible]

[illegible] [illegible]town or [illegible] fault

Trend: Inferred in part, extends [illegible] Choctaw County [illegible] in part and [illegible] southeast in part for a distance of [illegible] mi ([illegible] km).

Age: Oligocene or younger

Type: Normal, dip is to the south and southwest.

Displacement: [illegible] in western Choctaw County, the [illegible] on the upthrown [illegible] fault is in fault contact with the [illegible] Limestone of [illegible] age on the downthrown side. The estimated displacement at this exposure

near Melvin in the SW¼ sec. 12, T. 1. N., R. 5 W. is 120 ft (37 m). South of Okatuppa near the SW cor. sec. 9, T. 11 N., R. 4 W., clay near the base of the Lisbon (middle Eocene) on the upthrown side of the fault is within 50± ft (15± m) of the base of the Moodys Branch Formation (upper Eocene) and displacement is estimated to be [illegible] ft ([illegible]± m). Eastward from near Okatuppa to the Tombigbee River, the fault displaces formations of the Claiborne Group and an absence of marker beds precludes accurate determinations of displacements.

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Turner, J. D., and Newton, J. G., 1971, Geologic map of Choctaw County, Alabama: Alabama Geol. Survey Map [illegible].

Gilbertown fault zone — Choctaw County - 3
James Creek fault

Trend: Inferred, NE-SW (N 80° E) for a distance of 1.6 mi ([illegible] km) from the NW¼ sec. [illegible], T. [illegible] N., R. 5 W. to the NW¼SE¼ sec. 7, T. 11 N., R. 5 W.

Age: Late Eocene or younger

Type: Normal, dips to the northwest

Displacement: Approximately 25 ft (8 m) as estimated from geologic map of Tourtelot and Morris (1944) and Turner and Newton (1971). Chunnenuggee Member of the Yazoo Clay is in fault contact with the Cocoa Sand Member of the Yazoo Clay. Stratigraphic section eliminated by the fault includes part of the Cocoa and the Pachuta Marl Member of the Yazoo.

References:

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Gilbertown fault zone — Choctaw County - 4
[illegible] to South [illegible]tertown fault

Trend: [illegible] inferred NW-SE ([illegible] W), for a distance of [illegible] mi ([illegible].5 km) from the [illegible] sec. 35, T. [illegible] N., R. 4 W. to NW¼ sec. 5, T. [illegible] N., R. 3 W.

Age: Late Eocene or younger

Type: Normal, dips to northeast

Displacement: [illegible] ft ([illegible] m), [illegible] of fault [illegible] [illegible] Formation of the [illegible] in fault contact with the Lisbon Formation (middle Eocene) in the [illegible] sec. [illegible], T. [illegible] N., R. 3 W.

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[illegible]town fault zone — Choctaw County - [illegible]
[illegible] to Womack Hill fault

Trend: [illegible] (N [illegible] to 65 W) for a distance of [illegible] mi ([illegible] km) from [illegible] of [illegible] in the [illegible] sec. [illegible], T. [illegible], R. 3 W., to northwest of Womack Hill in the N½ sec. [illegible], T. 10 N., R. 2 W.

Age: Miocene or younger

Type: Normal, dips to the south

Displacement: [illegible]± ft ([illegible]± m). In the [illegible] sec. 5, T. [illegible] N., R. [illegible] W., and the [illegible] sec. [illegible], T. [illegible] N., R. [illegible] W., undifferentiated deposits of Miocene age? and the [illegible] [illegible] age are in fault contact with the [illegible] Formation of middle Eocene, Claiborne age. [illegible] formations of upper Eocene age with a total thickness of [illegible] ft ([illegible] m) are absent due to the fault. Further to the west along the fault the displacement is less.

Reference:

Turner, J. D., and Newton, J. G., 1971, Geologic map of Choctaw County, Alabama: Alabama Geol. Survey Map 1[illegible]2.

Gilbertown fault zone
South Gilbertown fault — Choctaw County - 6

Trend: Generally NW-SE, trend is mainly inferred from subsurface data. Fault extends for a distance of [illegible] mi ([illegible] km) from the [illegible] sec. [illegible], T. [illegible] N., R. [illegible] W. to the [illegible] sec. [illegible], T. [illegible] N., R. [illegible] W.

Age: Late Eocene or younger

Type: Normal, dips to north and northeast

Displacement: 50 to 100 ft (15 to [illegible] m). Formations of the Jackson Group on the downthrown side are in fault contact with the Lisbon Formation on the upthrown side. In the NW¼NE¼ sec. 34, T. [illegible] N., R. [illegible] W., the [illegible] Member of the Yazoo Clay is in fault contact with the Lisbon Formation and displacement is estimated to be from 50 to [illegible] ft ([illegible] to [illegible] m). An absence of exposed key marker beds in the Lisbon Formation along most of the fault precludes accurate determinations of displacements.

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Turner, J. D., and Newton, J. G., 1971, Geologic map of Choctaw County, Alabama: Alabama Geol. Survey Map 1[illegible].

Bladon Springs fault (north) — Choctaw County - 7

Trend: Generally northwest-southeast (N 70° W) for a distance of 1.6 mi (2.6 km) from the NE¼SE¼ sec. 1[illegible], T. 9 N., R. 3 W. to the NE¼NW¼ sec. 17, T. 9 N., R. 2 W.

Age: Middle Eocene (Claiborne or younger)

Type: Normal, dips [illegible] northeast

Displacement: [illegible] ft ([illegible] m) plus. The upper part of the [illegible] Formation and the Hatchetigbee Formation [illegible] fault contact. Stratigraphic section absent [illegible] the fault includes the lower 50 ft (15 m) of the [illegible] Formation and an undetermined amount [illegible] Formation. The elevation of [illegible] contact north [illegible] the fault (downthrown side) is [illegible] ft ([illegible] m) in the NW¼[illegible] sec. 7, [illegible] W. [illegible] and Hatchetigbee Formations are in fault contact at an elevation of [illegible] ft ([illegible] m), in the [illegible] sec. 7, T. [illegible] N., R. [illegible] W.

References:

Turner, [illegible], and Newton, J. G., 1971, Geologic map of Choctaw County, Alabama: Alabama Geol. Survey Map [illegible].

[illegible] Springs Fault (south) — Choctaw County - 8

Trend: [illegible] for a distance of [illegible] mi [illegible] from the [illegible] sec. [illegible], T. [illegible] N., R. [illegible] W., [illegible] sec. [illegible], T. [illegible] N., R. [illegible] W. (Choctaw County-Washington County boundary).

Age: Middle Eocene (Claiborne) or younger

Type: Normal, [illegible] southwest, inclination of fault [illegible]

Displacement: [illegible] The [illegible] part of the [illegible] Formation [illegible] and the [illegible] mi ([illegible] km) north [illegible] County boundary in the [illegible] lower [illegible] Formation [illegible] contact south of [illegible] The fault [illegible] of the road [illegible] on either side of the fault are undeformed and essentially horizontal.

References:

MacNeil, F. S., 1946, Geologic map of the Tertiary formations of Alabama: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 45.

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Bashi Creek fault — Clarke County - 1

Trend: Inferred in part, strike is approximately N 87° W, fault extends for about 1.2 mi (1.9 km) from SE¼NE¼ sec. 8 to NE cor. SE¼ sec. 9, T. 1[illegible] N., R. 1 E.

Age: Lower Eocene-Sabine Stage (Hatchetigbee) or younger.

Type: Normal, dips to northeast

Displacement: Approximately 25 ft (8 m) as estimated in SE¼NW¼ sec. 9, T. 1[illegible] N., R. 1 E. Fault displaces Bashi Marl Member of Hatchetigbee Formation along Alabama Highway 69.

References:

Toulmin, L. D., and Newton, J. G., 1963, Profile showing geology along State Highway 69 and County Highway 15, Clarke County, Alabama: Alabama Geol. Survey Map 27.

Causey, L. V., and Newton, J. G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

Harris Creek fault — Clarke County - 2

Trend: Inferred in part and arcuate, generally NW-SE (N 65° W) for a distance of 4 mi (6.4 km) from SW¼ sec. 10, T. 10 N., R. 1 W. to NW¼SW¼ sec. 20, T. 1[illegible] N., R. 1 E.

Age: Late Eocene or younger

Type: Normal, dips to southwest

Displacement: Approximately 90 ft (27.4 m) as estimated in the NW cor. of NE¼ sec. 14, T. 10 N., R. 1 W. where the North Twistwood Creek Member of the Yazoo Clay on the downthrown side is in fault contact with the lower half of the Lisbon Formation on the upthrown side.

References:

Causey, L. V., and Newton, J. G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

West Bend fault — Clarke County - 3

Trend: Inferred in part at western end and gently arcuate generally NW-SE for a distance of about 27.5 mi (44 km) from SW¼ sec. [illegible], T. [illegible] N., R. [illegible] W. to near SE cor. sec. [illegible], T. 8 N., R. 3 E.

Age: Miocene or younger

Type: Normal, dips to southwest

Displacement: [illegible] estimated from outcrop data. [illegible] Miocene [illegible] fault is in fault contact with the [illegible] Formation (upper Eocene-Jackson). In the [illegible] sec. [illegible] Limestone [illegible] downthrown side of the fault is in fault contact with the lower part of the Lisbon Formation (middle Eocene-Claiborne) on the upthrown side of the fault. [illegible] fault prevents more precise estimates.

References:

MacNeil, F. Stearns, [illegible], Geologic map of the Tertiary formations of Alabama: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 45.

Causey, L. V., and Newton, J. G., [illegible], Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

Satilpa Creek fault, north of U.S. Highway 84 — Clarke County - 4

Trend: Inferred in part, generally NW-SE (N 72° W) for a distance of 1.7 mi (2.7 km) from NE¼SW¼ sec. 6 to NW¼NW¼ sec. 9, T. 9 N., R. 1 E.

Age: Miocene or younger

Type: Normal, dips to northeast

Displacement: Approximately 25 ft (8 m). The Miocene Series on the downthrown side of the fault is in fault contact with the Marianna Limestone on the upthrown side in the SW¼[illegible]¼ sec. 5, T. 9 N., R. 1 E. The contact of the Miocene Series with the underlying Bucatunna Clay Member of the Byram Formation (Oligocene) north of the fault (downthrown side) is at an elevation of 75 ft ([illegible] m). The upper part of the Marianna Limestone south of the fault (upthrown side) is at an elevation of 65 ft (20 m) in the N[illegible]¼ sec. 8, T. 9 N., R. 1 E.

Reference:

Causey, L. V., and Newton, J. G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

Coffeeville fault — Clarke County - 5

Trend: Arcuate, inferred in part, generally NW-SE, approximately N 35° W for a distance of [illegible] mi ([illegible] km) from SW¼NW¼ sec. 1[illegible], T. 9 N., R. 1 W. to N[illegible]¼[illegible]¼ sec. 2[illegible], T. 8 N., R. 2 E. forms south boundary of major graben system.

Age: Miocene or younger

Type: Normal, dips northeast

Displacement: Approximately 100 ft (30 m), as determined from outcrop data. Miocene-Oligocene contact north of the fault (downthrown side) in the NW¼NW¼ sec. 2[illegible], T. 9 N., R. 1 E. is at an elevation of [illegible] ft ([illegible] m) (projected elevation of the base of the Moodys Branch Formation is -10 ft [-3 m]). The elevation of the Red Bluff Clay south of the fault (upthrown side) near the southeast corner of sec. 21, T. 9 N., R. 1 E. is 233 ft (71 m) (projected elevation of the base of the Moodys Branch is 133 ft [41 m]).

The elevation of the top of the Glendon Limestone Member of the Byram Formation near the southwest corner of sec. [illegible], T. [illegible] N., R. 1 E. north of the fault (downthrown side) is 1[illegible]5 ft (59 m) (projected elevation of the base of the Moodys Branch is mean sea level). [illegible] of the [illegible] south of the fault (upthrown side) is [illegible] ft ([illegible] m) (projected elevation of the base of the Moodys Branch is 1[illegible]5 ft [[illegible] m]).

[illegible] displacement is estimated to be 75 ft ([illegible] m) in an outcrop where the lower part of the [illegible] Series on the downthrown side of the fault is in fault contact with the lower [illegible] on the upthrown side. In the SW¼ sec. [illegible], T. 9 N., R. 1 E., displacement is estimated to be approximately 75 ft ([illegible] m) in an outcrop where the Marianna Limestone on the downthrown side of the fault is in fault contact with the Jackson Group on the upthrown side.

Reference:

[illegible], 1945, Geologic map of the Tertiary formations of Alabama: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 45.

[illegible], and Newton, [illegible] G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

[illegible] Creek fault, [illegible] U.S. Highway 84 — Clarke County - 6

Trend: Inferred in part, [illegible] NW-SE [illegible] W for a distance of [illegible] mi ([illegible] km) from [illegible] sec. [illegible], T. 9 N., R. 1 E. to the NW¼NE¼ sec. 29, T. 9 N., R. [illegible] E.

Age: Late Eocene or younger

Type: Normal, dip is northeast. Inclination of fault is 80°.

Displacement: About [illegible] ft ([illegible] m) as measured in field [illegible] sec. 2[illegible], T. 9 N., R. 1 E. The Moodys Branch Formation (late Eocene) on the downthrown side of the fault is in fault contact with the [illegible] Formation on the upthrown side. The Moodys Branch-[illegible] contact on the downthrown side is at an elevation of [illegible] ft ([illegible] m) and the elevation of the Moodys Branch-[illegible] contact on the upthrown side is [illegible]5 ft ([illegible] m). The fault plane is clearly defined (fig. [illegible]) and can be

traced from the base of the exposure to within 3 ft (1 m) of the land surface. The gouge zone on either side of the fault is approximately 6 in (.15 m) wide.

References:

Causey, L. V., and Newton, J. G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

Winn - McVay fault Clarke County - 7

Trend: Inferred in part, sinuous and arcuate, generally north to south and southeast, for a distance of 6 mi (9.7 km) from mid point of section line common to secs. 7 and 8, T. [illegible] N., R. [illegible] E. to [illegible] sec. 8, T. 7 N., R. 2 E.

Age: Miocene or younger

Type: Normal, dips to east and northeast

Displacement: Approximately 75 to 100 ft (23 to 30 m) as estimated in NW¼ sec. [illegible], T. 8 N., R. 2 E. Miocene undifferentiated occurs east of the fault at an elevation of [illegible] ft ([illegible] m). Cocoa Sand Member of the Yazoo occurs at 24[illegible] ft (73 m) near the fault on the west side. Also on the west side ½ mile from the fault Jackson-Lisbon contact is at an elevation of 16[illegible] ft (50 m). The fault displaces units of the Jackson Group, the Oligocene Series and the Miocene Series.

References:

Causey, L. V., and Newton, J. G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

Allen fault Clarke County - 8

Trend: NW-SE (N 52° W) for a distance of 5.5 mi (8.8 km) from SE¼ sec. 32, T. 8 N., R. 3 E. to SW¼ sec. 18, T. 7 N., R. 4 E.

Age: Miocene or younger

Type: Normal, dips to southwest. Probably is a southeastern extension of the West Bend fault.

Displacement: Approximately 75 ft (23 m) as estimated in [illegible] sec. [illegible], T. 7 N., R. 3 E. Upper half of Jackson Group on the upthrown side of the fault is in fault contact with the Marianna Limestone on the downthrown side. Yazoo Clay in area is estimated to be 100 ft ([illegible] m) thick and the thickness of the Marianna in the area is estimated to be 50 ft (15 m).

References:

Causey, L. V., and Newton, J. G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

Walker Springs Clarke County - 9

Trend: Inferred generally N-S (N 3° W) for a distance of 2.[illegible] mi ([illegible] km) from [illegible] part of section line common to secs. [illegible] and [illegible], T. 7 N., R. 3 E. to SW¼SW¼ sec. 3[illegible], T. 7 N., R. 3 E.

Age: Miocene or younger

Type: Normal, dips to west

Displacement: Estimated [illegible] m). Upper part of Oligocene Series on the downthrown side of the fault is in fault contact with the lower part of the Oligocene Series on the upthrown side.

References:

Causey, L. V., and Newton, J. G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

Jackson fault Clarke County - 1[illegible]

Trend: Southern part of fault trends N [illegible] for a distance of [illegible] mi ([illegible] km) from [illegible] sec. [illegible], T. [illegible] N., R. 2 E., to the vicinity of [illegible] Bassett Creek; northern part of fault trace trends N [illegible] W for a distance of [illegible] mi ([illegible] km) to near Jackson [illegible] in [illegible] sec. [illegible], T. 6 N., R. [illegible] E. [illegible] length of fault is [illegible] mi ([illegible] km). A [illegible] west of the Jackson fault has been mapped for a distance of [illegible] mi ([illegible] km) from near the southeast corner of sec. [illegible], T. 5 N., R. [illegible] E. to the NW¼[illegible] sec. [illegible], T. 6 N., R. [illegible] E. The [illegible] is down to the west, apparently normal, and exposes [illegible] of Oligocene [illegible] on the downthrown side. The Jackson fault at the southern end is covered by alluvium of the Tombigbee River.

Age: Miocene or younger. Sediments of undifferentiated Miocene-Pliocene age are displaced along the fault.

Type: Normal, southern part dips northwest and northern part dips southwest.

Displacement: Displacement along the fault is about 1,400 ft (427 m)(Toulmin, 1962, p. 40) at Salt Mountain but decreases northward and is about 50 ft (15 m) in the vicinity of Jackson Creek (Causey and Newton, 1972).

In the SE¼ sec. 33, T. 6 N., R. 2 E., the Oligocene Series (Marianna Limestone) on the downthrown side of the fault is in fault contact with the Naheola Formation (Midway Group) on the upthrown side and displacement is estimated to be 1,400 ft (427 m). In an exposure in Little Stave Creek in the NE¼ sec. 30, T. 7 N., R. 2 E., the upper part of the Oligocene Series (Chickasawhay Limestone) on the downthrown side of the fault is in fault contact with the Tallahatta Formation (middle Eocene-Claiborne) on the upthrown side and displacement along the fault at this point is estimated to be [illegible] ft ([illegible] m). In an exposure in the SW¼ sec. 18, T. 7 N., R. 2 E., the lower part of the Oligocene Series on the downthrown side of the fault is in fault contact with the lower part of the Lisbon Formation (middle Eocene-Claiborne) on the upthrown side and displacement is estimated to be 200± ft (61± m). Near the northwestern end of the fault in the SE¼ sec. 2, T. 7 N., R. 1 E. the Lisbon Formation on the downthrown side of the fault is in fault contact with the Tallahatta Formation on the upthrown side and displacement is about 50 ft (15 m).

References:

Smith, E. A., Johnson, L. C., and Langdon, D. W., Jr., 1894, Report on the geology of the Coastal Plain of Alabama: Alabama Geol. Survey, Special Rept. 6, p. 2[illegible]-[illegible]5.

Toulmin, L. D., 1940, The Salt Mountain Limestone of Alabama: Alabama Geol. Survey. Bull. 46, p. 57.

______ 1962, Geologic section along Little Stave Creek, 3.5 miles north of Jackson, Alabama, on the west side of U.S. Highway 43 and description of section on Clarke County Highway 15 between Salt Creek and Rockville on the upthrown side of the Jackson fault, in Gulf Coast Assoc. of Geological Societies Guidebook 12th Field Trip: p. 16-27 and 34-41.

Adams, G. I., Butts, Charles, Stephenson, L. W., and Cooke, C. W., 1926, Geologic Map of Alabama: Alabama Geol. Survey Spec. Map 7.

MacNeil, F. Stearns, 1946, Geologic map of the Tertiary formations of Alabama: U.S. Geol. Survey, Oil and Gas Prelim. Map 45.

Causey, L. V., and Newton, J. G., 1971, Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

Upper State Game Sanctuary fault — Clarke County - [illegible]

Trend: Inferred in part, generally NE-SW (N 50° E, for a distance of 2 mi (3.2 km) from NE cor. sec. 33 to SW¼SE¼ sec. 23, T. 7 N., R. 1 E.

Age: Miocene or younger

Type: Normal, dips to southeast

Displacement: [illegible] of the upper part of the Jackson [illegible] and the Miocene Series on [illegible] of the fault [illegible] fault contact with [illegible] of the [illegible] and the Miocene [illegible] the downthrown side. Displacement [illegible] ft ([illegible] m), [illegible] estimated [illegible] to secs. [illegible] 6 and 17, T. 7 N., R. [illegible] E. [illegible] of the [illegible] Marl [illegible] of the [illegible] of the upthrown side of the fault [illegible] ft ([illegible]) and the [illegible] of the Byram Formation with the [illegible] Marianna Limestone on the downthrown side [illegible] ft ([illegible] m).

References:

Causey, [illegible], and Newton, [illegible], [illegible], Geologic map of Clarke County, Alabama: Alabama Geol. Survey Map 95.

[illegible] fault or [illegible] Flat Creek fault — Monroe County - [illegible]

Trend: [illegible], generally north-[illegible] and arcuate from [illegible], T. [illegible] N., R. [illegible] E., to NW[illegible] sec. [illegible], T. [illegible] N., R. [illegible] E. for a distance of [illegible] mi ([illegible] km).

Age: Lower Eocene (Sabine Stage) or younger

Type: Normal, dips to west

Displacement: Approximately 40 to 50 ft (12 to 15 m) as estimated from elevations on the Bashi Marl Member of the Hatchetigbee Formation of 110 ft (33 m) in the NW cor. of sec. 36, T. 9 N., R. 7 E. on the downthrown side and 150 ft (46 m) on the upthrown side in the NE¼NW¼ sec. 31, T. 9 N., R. 8 E.

Reference:
Scott, J. C., 1971, Geologic map of Monroe County, Alabama: Alabama Geol. Survey Map 1[illegible]1.

Monroe west graben fault — Monroe County - 2

Trend: Generally north-south and sinuous from NW¼NE¼ sec. 3, T. [illegible] N., R. 7 E., to N[illegible]¼[illegible]¼ sec. 27, T. 9 N., R. 7 E. for a distance of [illegible].0 mi ([illegible] km).

Age: Middle Eocene or younger

Type: Normal, dips to east

Displacement: Approximately 50 ft (15 m). Lisbon Formation on upthrown side is in contact with Tallahatta Formation on downthrown side in roadcuts in SW¼SE¼ sec. 3, T. 9 N., R. 7 E.

Reference:
Scott, J. C., 1971, Geologic map of Monroe County, Alabama: Alabama Geol. Survey Map 101.

Frankville fault zone — Washington County - 1
Friendship Church fault

Trend: Northwest-southeast (N 50° W) inferred in part, extends for a distance of 1.9 mi (3 km) from the NE¼ sec. 5, T. 8 N., R. 2 W. to the SE¼NW¼ sec. 10, T. 8 N., R. 2 W.

Age: Middle Eocene (Claiborne) or younger

Type: Normal, down to the northeast, dip is about N 30° E.

Displacement: Less than 25 ft (8 m). The Lisbon Formation of Claiborne age is in fault contact with the Tallahatta Formation of Claiborne age. The absence of key marker beds in a highly weathered exposure of the fault precludes an accurate determination. The fault is well exposed on the southside of a dirt road in the NW¼NE¼SW¼ sec. 4, T. 8 N., R. 2 W.

Reference:
Turner, [illegible] D., and Newton, J. G., 1971, Geologic map of Washington County, Alabama: Alabama Geol. Survey Map 100.

Frankville fault zone — Washington County - 2

Trend: Northwest-southeast (N 5[illegible] W) inferred in part, extends for a distance of 4.2 mi (6.7 km) from the Washington-Choctaw County boundary in the [illegible]¼NW¼ sec. 5, T. 8 N., R. [illegible] W. to the [illegible]¼[illegible]¼ sec. 1[illegible], T. 8 N., R. 2 W.

Age: Middle Eocene (Claiborne) or younger

Type: Normal, down to the southwest

Displacement: Less than 25 ft (8 m). The Lisbon Formation (Claiborne) on the downthrown side of the fault is in fault contact with the Tallahatta Formation (Claiborne) on the upthrown side.

Reference:
Turner, J. [illegible], and Newton, J. G., 1971, Geologic map of Washington County, Alabama: Alabama Geol. Survey Map 100.

Frankville fault zone — Washington County - 3

Trend: Northwest-southeast (N [illegible] W) extends for a distance of [illegible] mi ([illegible] km) from the SW¼[illegible]¼ sec. 5, T. 8 N., R. 2 W. to the NW cor. sec. 9, T. [illegible] N., R. 2 W. to the NW cor. sec. 9, T. 8 N., R. 2 W.

Age: Middle Eocene (Claiborne) or younger

Type: Normal, down to the northeast

Displacement: Less than 25 ft (8 m). The Lisbon Formation (Claiborne) on the downthrown side of the fault is in fault contact with the Tallahatta Formation (Claiborne) on the upthrown side. The fault plane is exposed in a highly weathered outcrop in the NE¼[illegible]¼ sec. 5, T. 8 N., R. 2 W.

Reference:
Turner, [illegible], and Newton, J. G., 1971, Geologic map of Washington County, Alabama: Alabama Geol. Survey Map 100.

RELATIONSHIPS OF SURFACE AND SUBSURFACE FAULTS IN CHOCTAW AND CLARKE COUNTIES, ALABAMA[1]

By C. V. Wilson,[2] J. T. Kidd,[2] and S. W. Shannon[3]

INTRODUCTION

This report summarizes the results of a short-term investigation of the relationships between faults mapped on the surface and subsurface faults interpreted from test-well data in eastern Choctaw and western Clarke Counties, Alabama. Work was concentrated in two areas, the first being within part of the Gilbertown fault zone in the vicinity of field trip Stop [illegible], and the second being in part of the West Bend-Coffeeville fault zone adjacent to field trip Stops 9, 1[illegible], and [illegible].

Formation tops, fault locations and vertical displacements or throws were determined by use of electric logs for the oil-test wells in the areas. These data were correlated with similar data from nearby wells and compared with results of previous investigations in the area (not[illegible]y, Moore, 19[illegible]; Wilson and Kidd, [illegible]). Information on surface faults is after Turner and Newton ([illegible]) and [illegible]y and Newton ([illegible]). Depths referred to in this report relative to displacements by faults at specific geologic horizons are in feet (ft) and meters (m) below mean sea level and are preceded by a minus sign.

Units offset by faults in the area range in age from Jurassic or pre-Jurassic to Miocene. Tertiary and later Cretaceous strata described elsewhere in this guidebook are not described here. Early Late Cretaceous or Jurassic strata do not crop out in the State and a brief description of these units follows (fig. 13).

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[1] Publication approved by the Acting State Geologist.

[2] State Oil and Gas Board

[3] Geological Survey of Alabama

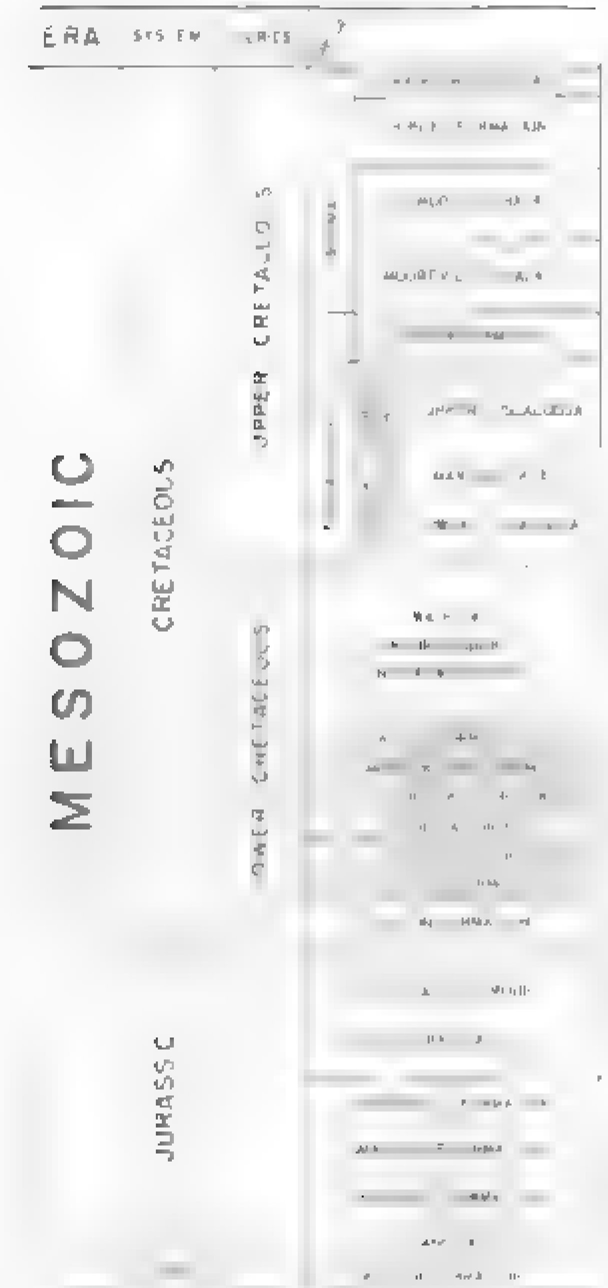


Figure 13.—Jurassic and Cretaceous formations in south Alabama. (From Copeland, 1968)

JURASSIC SYSTEM

Jurassic rocks underlying the area of study include, in ascending order, the Louann Salt, Norphlet Formation, Smackover Formation, Buckner Anhydrite Member of the Haynesville Formation, Haynesville Formation, and Cotton Valley Group. The combined thickness of these formations is not known since test-wells are generally bottomed in the upper part of the Norphlet Formation. The interval from the top of the Norphlet Formation to the top of the Cotton Valley Group in the areas of study range from about [illegible] to 3,300 ft (762 to 1,007 m). A test-well located near Womack Hill in Choctaw County penetrated [illegible] ft ([illegible] m) of the Norphlet Formation before entering the Louann Salt. The present thickness of Louann Salt within the Gilbertown-West Bend-Coffeeville fault zone is believed to vary greatly due to past flowage. The original thickness of the salt is unknown.

The Louann Salt is a clear to grayish-white salt with occasional streaks of anhydrite. The updip limit of the salt approximately parallels the peripheral fault system and the salt decreases rapidly in thickness updip from the fault grabens.

The Norphlet Formation, which overlies the Louann Salt, is composed mostly of grayish-white sandstone with some gravel and minor amounts of shale.

Overlying the Norphlet Formation is the Smackover Formation which consists mainly of limestone and dolomite. In the Womack Hill area in Choctaw County the Smackover averages about 375 ft (114 m) in thickness. This carbonate unit thins in an eastward direction and has an average thickness of 1[illegible] ft ([illegible] m) in the northwest Clarke County study area.

The Buckner Member is a massive anhydrite in the lower part of the Haynesville Formation. In eastern Choctaw County the Buckner averages about 50 ft (15 m) in thickness, whereas in western Clarke County the formation has a thickness that averages about 125 ft (38 m). Above the Buckner the Haynesville consists mostly of thin bedded anhydrite, shale, and salt with lesser amounts of limestone and sandstone. The total thickness of the Haynesville is between 1,000 and 1,200 ft (305 to 366 m), in the Womack Hill area and between 500 and 1,000 ft (152 to 305 m) in the study area of northwest Clarke County.

The Cotton Valley Group, which overlies the Haynesville Formation, consists predominantly of pink and gray sandstones, with lesser amounts of purple, gray, and green shales. This clastic sequence has an average thickness of about 1,800 ft (549 m) in the Womack Hill area in Choctaw County and in northwest Clarke County generally ranges in thickness from 1,400 ft to 2,000 ft (427 to 610 m)

LOWER CRETACEOUS SERIES

The Lower Cretaceous Series is usually not subdivided in south Alabama outside of the Citronelle oil field in Mobile County. The Lower Cretaceous Series in Choctaw and Clarke Counties consists mostly of interbedded sandstone and shale with dark nodular limestone and red and green shale in the upper part. The total thickness is estimated to average about [illegible] ft ([illegible] m) in eastern Choctaw County and 3,[illegible] ft ([illegible] m) in northwest Clarke County.

Sediments assigned to the "Lower Tuscaloosa" interval are [illegible] in age. This unit consists of several hundred feet of beds of massive sandstone with thin interbeds of shale.

SUBSURFACE INVESTIGATION OF A FAULT IN THE [illegible]TOWN [illegible]

[illegible] VI[illegible]

A subsurface investigation was made of a major fault [illegible] on the surface [illegible] fault [illegible] Cho-5, [illegible] The study involved [illegible] from [illegible] and [illegible] in the [illegible] and the determination from [illegible] of [illegible] fault [illegible]. The fault studied extends from the [illegible] central part [illegible] eastward [illegible] west corner [illegible]. This fault has been mapped in the subsurface [illegible] with a fault that extends from the [illegible] River in a [illegible] direction for a length that may exceed [illegible] (Moore, 1971). In the opinion of the authors the surface fault [illegible] Cho-5 is continuous with the [illegible] central Clarke County [illegible]. [illegible] the fault in the surface in the vicinity of the [illegible] River [illegible] because of the cover of alluvial deposits in this area and lack of exposure.

Table 1. List of wells illustrated or index maps, geologic maps, and cross sections.

State Oil and Gas Board Permit Number	Well Name And Operator	Location	Total Depth (ft)
200	J. B. Evans, Jr. J. W. Rudder No. 1	990'SNL & 990'WEL SE¼SW¼ sec. 31, T. 11 N., R. 3 W.	4,03[illegible]
202	J. B. Evans, Jr. Eula Abston No. 1	990'SNL & 990'WEL [illegible]NW¼ sec. [illegible], T. 10 N., R. 3 W.	3,44[illegible]
207	H. C. Sloan Robert Lee Thornton, Sr. et al No. 1	330'E & 330'S NW/cor. SW¼SE¼ sec. [illegible], T. [illegible] N., R. [illegible] W.	3,46[illegible]
229	Harold N. Hawkins Mattie Clarke No. 1	521.5'WEL & 578.5' SNL NW¼NE¼ sec. 1, T. 10 N., R. 3 W.	3,438
233	J. B. Evans, Jr. Eula Abston Jones No. [illegible]	330'SNL & 330'EWL SE¼SW¼ sec. [illegible], T. [illegible] N., R. 3 W.	3,415
278	Marshall Oglesby Mattie Clarke No. 1-A	330'SNL & 330'WEL [illegible] sec. [illegible], T. [illegible] N., R. 3 W.	3,45[illegible]
316	Justiss-Mears Oil Company Mattie Clarke No. 2	330'EWL & 100'NSL NW¼NE¼ sec. 1, T. 10 N., R. 3 W.	3,563
574	Carter Oil Co. C. F. Stewart No. 1	670'S & 653'W Cen. NE/cor. SE¼NW¼ sec. 6, T. 10 N., R. 2 W.	3,860
603	Robert Sigler & Wallace E. Gunn Marcita Dansby et al No. 1	Cen. NE¼SW¼ sec. 6, T. 10 N., R. 2 W.	3,529
1071	Marshall Oglesby Frank Gibson No. 1	SW¼NW¼SW¼ sec. 1, T. 10 N., R. 3 W.	3,437
1102	Marshall Oglesby No. 1 C. B. Morgan	330'EWL & 330'SNL SW¼SW¼ sec. 1, T. 10 N., R. 3 W.	1,102

Table 1 - continued

State Oil and Gas Board Permit Number	Well Name And Operator	Location	Total Depth (ft)
1242	R. Merrill Harris [illegible] C. Hare No. 1	614.8'S & 633.2'E NW/cor. SE¼NE¼ sec. 1[illegible], T. 10 N., R. 1 E.	3,536
1[illegible]	Harry E. Newkirk, Jr. Mattie E. Clarke No. 1	330'EWL & 330'NSL NW¼[illegible] sec. 1, T. 10 N., R. 3 W.	3,438
1[illegible]84	Catmoco Services Co., Inc. Grief Brothers Cooperage Corp. et al No. 1	653'N & 660'E SE/cor. SE¼SW¼ sec. 18, T. 9 N., R. 1 E.	5,8[illegible]
1[illegible]73	Arde[illegible] A. Anderson & Harry E. Newkirk, Jr. C. F. Stewart Heirs et al No. 1	Cen. N[illegible]SW¼ sec. [illegible], T. 10 N., R. 3 W.	[illegible]
[illegible]97	M[illegible] Oglesby Unit No. 1-5	[illegible]'EWL & 33[illegible]'SNL SW¼NW¼ sec. 1, T. 10 N., R. 3 W.	3,[illegible]
[illegible]98	Arde[illegible] A. Anderson & Harry E. Newkirk, Jr. C. F. Stewart No. 2	[illegible] & 660'EWL [illegible]SW¼ sec. [illegible], T. [illegible] N., R. 3 W.	[illegible]
1515	Newkirk-Anderson Drilling & Exploration Co., Inc. Mattie E. Clarke No. 2	[illegible]'EWL & [illegible]'SNL [illegible] sec. [illegible], T. 10 N., R. 3 W.	[illegible]
[illegible]536	Newkirk-Anderson Drilling & Exploration Co., Inc. Mattie E. Clarke No. 3	[illegible]'EWL & 330'NSL [illegible] sec. 1, T. 10 N., R. 3 W.	3,[illegible]
[illegible]543	Choctaw Holdings, Inc. Eula Jones No. 1	[illegible]'EWL & 330'NSL [illegible]NW¼ sec. [illegible], T. 10 N., R. 3 W.	3,40[illegible]

Table 1 - continued

State Oil and Gas Board Permit Number	Well Name And Operator	Location	Total Depth (ft)
1347	American Petrofina Co. of Texas & Curtis A. Kinard W. D. Harrigan et al No. 4	Cen. SW¼NW¼ sec. 2[illegible], T. 10 N., R. 1 E.	3,534
1355	Anderson Oil Exploration Co. Unit 1-15 No. 1	330'SNL & 330'WEL SW¼SW¼ sec. 1, T. [illegible] N., R. 3 W.	3,415
1369	Anderson Oil Exploration Co. Mattie E. Clarke No. 4	330'SNL & 330'EWL SW¼NW¼ sec. 6, T. 10 N., R. 2 W.	3,390
1438	Humble Oil & Refining Co. W. D. Harrigan et al No. 1	3,181.4'NSL & 2,[illegible]1.7'FWL sec. 16, T. 10 N., R. 1 E.	12,071
1471	Skelly Oil Co. L. C. Deas No. 1	1,980'FNL & 1,980'FEL sec. 7, T. [illegible] N., R. 1 E.	14,307
1573	Pruet & Hughes-Pelto Oil Co. Carlisle Unit No. 16-4	660'FWL & 510'FNL sec. 16, T. 10 N., R. 2 W.	11,904
1591	Pruet & Hughes-Pelto Oil et al Scruggs, Parker & Norton Unit No. 9-14	554'FSL & 1,874'FWL sec. 9, T. 10 N., R. 2 W.	11,810
1635	Pruet & Hughes-Pelto Oil et al Martin et al Unit 9-12 No. 1	1,370'FSL & 790'FWL sec. 9, T. 10 N., R. 2 W.	11,974
1696	Pruet & Hughes A. J. Phillips Unit 12-12 No. 1	1,840'FSL & 630'FWL sec. 12, T. 10 N., R. 3 W.	12,305

Table 1 - continued

State Oil and Gas Board Permit Number	Well Name And Operator	Location	Total Depth (ft)
[illegible]097	Pruet & Hughes-Pelto Oil Co. McPhearson Unit 8-15 No. 1	1,980'FSL & 660'FSL sec. 8, T. 10 N., R. 2 W.	11,959
[illegible]	Pruet & Hughes-Pelto Oil Co. Chestnut Unit [illegible]-[illegible]0 No. [illegible]	5[illegible]'FWL & 1,943'FSL W½SE¼ sec. [illegible], T. 10 N., R. 3 W.	1[illegible],331
[illegible]768	Consolidated Gas Supply Corp. J. C. Hare 32-8 No. 1	660'FWL & 660'FSL SE¼NE¼ sec. 32, T. 10 N., R. 1 E.	1[illegible],[illegible]75
1[illegible]	Pruet & Hughes-[illegible] Oil Co. Lewis Unit [illegible] No. [illegible]	[illegible],840'FWL & 1,843'FSL sec. 1[illegible], T. 10 N., R. [illegible] W.	[illegible]
1[illegible]75	Pruet & Hughes Co. Stewart Unit 6-5 No. 1	64[illegible]'FWL & 6[illegible]'FNL sec. 6, T. 10 N., R. [illegible] W.	[illegible],775
[illegible]	[illegible] Exploration, Inc. Joe M. Gillmore et al No. [illegible]-5	[illegible]'FWL & [illegible]'FWL [illegible]SW¼ sec. [illegible], T. 9 N., R. [illegible] E.	1[illegible],[illegible]
1976	Arden A. Anderson Mattie E. Clarke Unit 1-1[illegible]	[illegible] sec. [illegible], T. 10 N., R. 3 W.	1[illegible],[illegible]
[illegible]64	Monroe Oil Co., Watkins & Marion Corp. W. S. Scruggs No. 1 Unit [illegible]	[illegible]'FNL & [illegible]'F[illegible]L sec. [illegible], T. 10 N., R. 3 W.	1[illegible],[illegible]
[illegible]38	Placid Oil Co. Pugh 5-4	5[illegible]0'FWL & [illegible]'FNL sec. 5, T. [illegible] N., R. 1 E.	1[illegible]

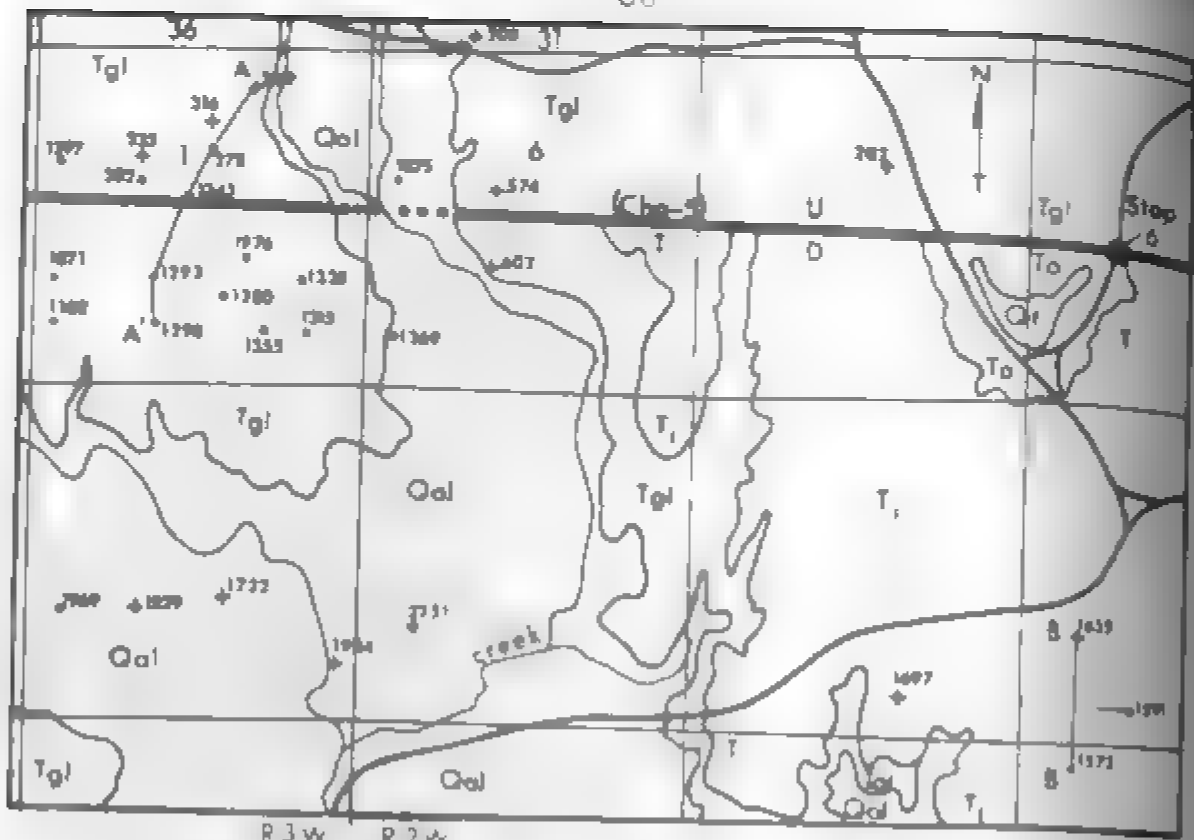
Table 1 - continued

State Oil and Gas Board Permit Number	Well Name And Operator	Location	Total Depth (ft)
2251	Energy Reserves Group & Wil-Ken Livery 7-12 No. 1	1,5[illegible]' FSL & 9[illegible]' FWL sec. 7, T. 10 N., R. 2 W.	12,21[illegible]

As previously mentioned the Cho-5 fault is exposed in a road cut in the NE¼NW¼NW¼ sec. 4, T. 10 N., R. 2 W. (Stop 6). The fault is normal, downthrown to the south and strikes [illegible] east-west (Turner and Newton, 1971). In the outcrop [illegible] steeply at an angle of about [illegible] and has a throw that is estimated to be approximately 15[illegible] ft (46 m). The [illegible] in the immediate vicinity of this surface fault is [illegible] in the discussion of Stop 6. In the subsurface the [illegible] of great significance since three separate oil [illegible] have thus far been discovered along its margins. In [illegible] eastern extent of the [illegible] field the fault is the [illegible] boundary fault of a relatively narrow horst structure within which oil was found to be trapped in sand of the [illegible] Formation at a depth of from -3,[illegible] to -3,4[illegible] ft (-[illegible] m). At the [illegible] of the [illegible] Formation the fault [illegible] roughly [illegible] ft ([illegible] m) south of its surface exposure. Further downdip, two oil fields have been discovered in the Smackover Formation of Jurassic age ([illegible] and Womack Hill fields). Both of these fields are [illegible] with east-west elongated anticlines that are [illegible] on the south flank by the fault under discussion [illegible] fault marks the northern limit of production. These [illegible] are believed to have been formed by movement [illegible] underlying [illegible] salt. [illegible] was probably [illegible] to fault movement [illegible] contemporaneous deposition [illegible] at the Smackover Formation [illegible] approximately 8,[illegible] ft ([illegible] m) south of its surface exposure at Stop 6.

In the immediate vicinity of the fault [illegible] of sec. 4, well-control [illegible] however, [illegible] enough to trace the fault [illegible] to 5 mi (8 to 8 km) west along the fault line from the outcrop in section 4 [illegible].

The fault [illegible] in well [illegible] at a depth of -1,[illegible] ft [illegible] throw of [illegible] m). [illegible] in the upper Eutaw Formation at [illegible] of -3,[illegible] ft (-9[illegible] m). The fault in [illegible] well [illegible] throw of about 735 ft ([illegible] m). In well [illegible] located [illegible] ft ([illegible] m) due west of well [illegible] the [illegible] of the [illegible] Group at [illegible] ft (-91[illegible] m). The throw is estimated [illegible] ft [illegible] m). [illegible] along the fault [illegible] well [illegible] the fault was penetrated [illegible] in the [illegible] Creek Formation at a depth of -2,180 ft (-66[illegible] m) where its throw is about 475 ft ([illegible] m).



EXPLANATION FOR FIGURES 14 AND 17

Qal	Alluvium and low terrace deposits	Pleistocene and Holocene	QUATERNARY
Qt	High terrace deposits		
Tpm	Pliocene and Miocene Series	Pliocene and Miocene	TERTIARY
To	Oligocene Series	Oligocene	
Tj	Jackson Group		
Tgl	Gosport Sand and Lisbon Formation	Eocene	
Tt	Tallahatta Formation		

Fault: dotted where covered

U, upthrown side

D, downthrown side

Oil-test well: dry hole

Oil-test well: producer

Contact

State Oil and Gas Board permit number

1175

Figure 14.--Geologic map of the vicinity of field trip Stop 6 showing the locations of oil-test wells and cross-sections A-A' and B-B'. Modified from Turner and Newton (1971)

Figure [illegible] north-south cross-section through the [illegible] oil field [illegible] the two major faults through [illegible] Cretaceous and Eocene strata. [illegible] in the [illegible] half of sec. [illegible], are intersected [illegible] down-to-the-north fault of the narrow horst block [illegible]. This fault has a northward [illegible] of about [illegible] to [illegible] lower Tertiary strata where its throw is about [illegible] (m). The fault also increases in displacement [illegible] Group the fault [illegible] to more than [illegible] m. This fault [illegible] the surface [illegible] the major fault [illegible] to the south.

[illegible]

[illegible]

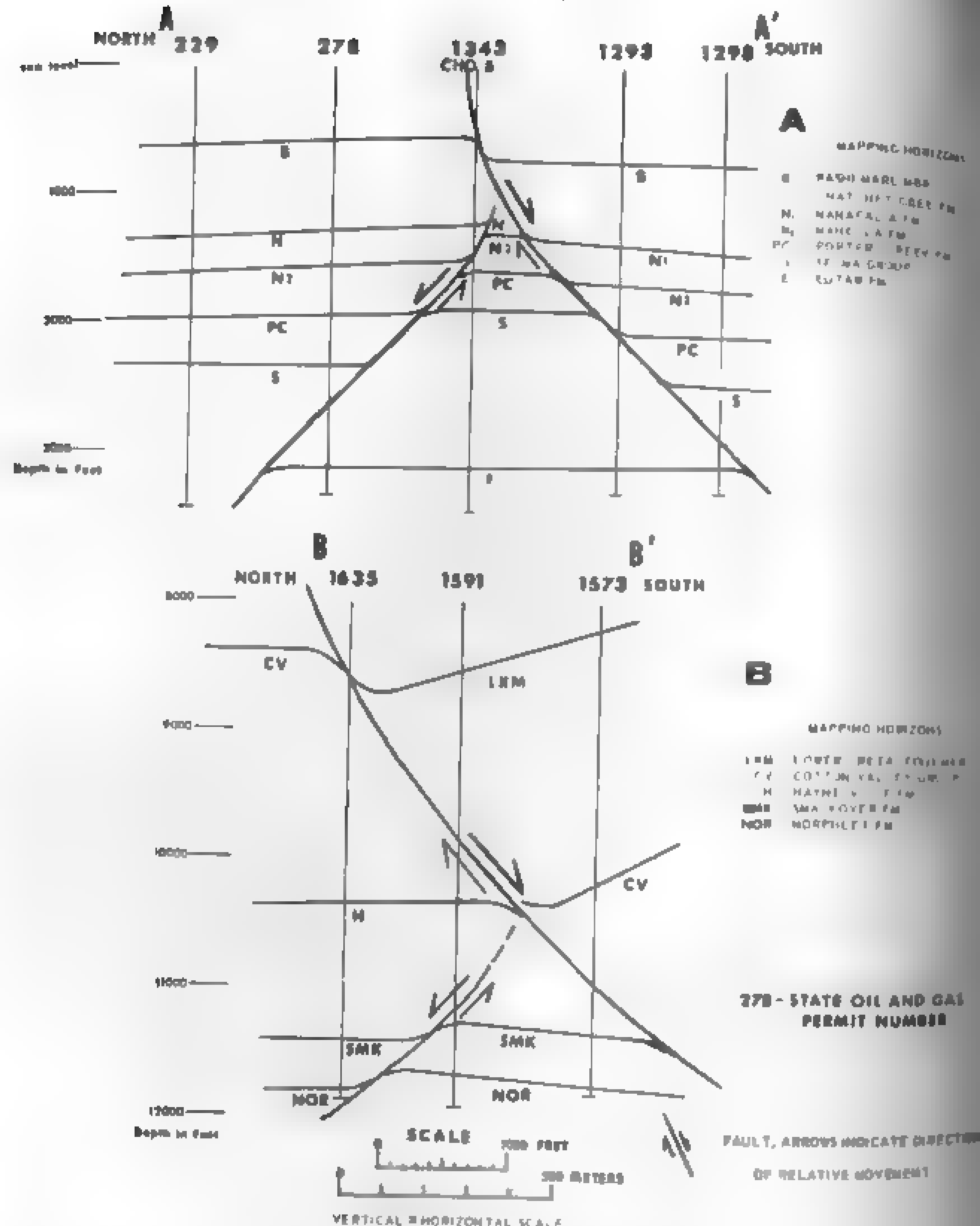


Figure 15.—Cross-sections through Choctaw County fault 5 (Cho-5).
A. Section A-A' through Cretaceous and Tertiary strata
B. Section B-B' through Jurassic strata.

[illegible] the dip of the fault and in well [illegible] the fault was [illegible]etrated at a depth of [illegible] ft ([illegible] m) where the throw was approximately [illegible] ft ([illegible] m). Further down-dip [illegible] in well 1573 the fault was encountered at a depth of [illegible] ft ([illegible] m) where the throw has decreased [illegible] approximately [illegible] ft ([illegible] m). The decrease in fault [illegible] of [illegible] ft ([illegible] m) or more between the Cotton Valley [illegible] and the Smackover Formation indicates a decrease in the dip of the fault of [illegible] or more.

The strike of the fault in the subsurface was determined to [illegible] very close to [illegible] which corresponds to the strike of the fault on the surface in the area of study.

[illegible] the small area included in the subsurface study [illegible] the Cho-5 fault, it appears that the throw of the fault increases in an eastward direction. The throw of the fault [illegible] in test-wells located in the western part of [illegible] from [illegible] to [illegible] ft ([illegible] to [illegible]) within strata of [illegible] to Late Cretaceous [illegible] fault throw [illegible] from about [illegible] to [illegible] ft ([illegible] to [illegible] m). Further [illegible] the fault throw increases to [illegible] ft ([illegible] to [illegible]) [illegible] the [illegible] increase in throw [illegible] from deep [illegible] test-wells in [illegible] indicates that the throw of the fault in the Cotton [illegible] Group [illegible] ft ([illegible] m) [illegible] part of the [illegible] ft ([illegible] m) [illegible] vicinity of [illegible] ft ([illegible] m) [illegible] the fault [illegible] Cotton Valley [illegible] is probably greater than [illegible] ft ([illegible] m).

[illegible] in agreement with [illegible] the presence of [illegible] thick sedimentary [illegible] indicates that the [illegible] with [illegible] and [illegible] movement [illegible] with [illegible] abnormally thick upper Cretaceous and lower Tertiary deposits.

WEST BEND-COFFEEVILLE FAULT ZONE

In Clarke County, Alabama, the West Bend-Coffeeville [illegible] mapped [illegible] surface [illegible] in limited exposures.

In general, formations of Eocene age are exposed to the north and south of the graben system on the upthrown sides of the West Bend and Coffeeville faults, whereas formations of Oligocene and Miocene age lie within the graben or the downthrown blocks, excluding Quaternary alluvium and terrace deposits.

Cross-section C-C' is a schematic diagram illustrating the West Bend-Coffeeville fault zone in the subsurface in T. 9 N., R. 1 E., and T. 10 N., R. 1 E., Clarke County, Alabama, in the vicinity of field trip Stops 9, 10, and 11 (figs. 16, 17, and 18). The West Bend fault is the major down-to-the-south fault and the Coffeeville fault is the major down-to-the-north fault. To facilitate discussion of cross-section C-C', the illustrated faults have been numbered consecutively from north to south, with fault no. 1 representing the West Bend fault, and fault no. 7 the Coffeeville fault. Faults mapped on the surface along C-C' have been cross-referenced to fault designations used by [illegible] (this guidebook) and are enclosed in parentheses. All wells illustrated on figs. 16, 17, and 18 are identified by Alabama State Oil and Gas Board permit numbers with more complete well data listed in table 1.

Fault no. 1 is not directly evident in the well data observed in the vicinity of cross-section C-C', nor is it **mapped on the surface** (Causey and Newton, 1971). However, **fault no. 1 is evident in the** subsurface to the east and **west, and projection of this fault** through cross-section **C-C' places the fault between** wells 1436 and 1347 at the **"Lower Tuscaloosa" horizon.** This interpretation agrees **with Moore (1971) who** mapped fault no. 1 approximately one **half mile (0.8 km) south** of well 1436 at the "Lower Tuscaloosa" horizon.

The presence of fault no. 2 is questionable. This fault is mapped in the subsurface based on elevation differences between the Haynesville, Smackover, and Norphlet Formations in wells 1768 and 2238. However, fault no. 2 **may not be present** as it apparently does not extend into **rocks of Cretaceous age.** Also, the apparent vertical displacement of Jurassic formations between wells 1768 and 2238 **can be accounted for with** a southerly dip of 8 to 10° if no **fault is present.**

Fault no. 3 (Harris Creek fault, Cla-2) lies approximately one-fourth mile (0.4 km) south of well 1347 (C-C'). This fault was not observed in the subsurface in the immediate vicinity of cross-section C-C' and apparently dies out near the surface in this area. However, this fault does **extend into the subsurface** to the west where it is **mappable at the "Lower Tuscaloosa" horizon. Therefore, the vertical displacement and subsurface extent** of this fault varies **along strike.**

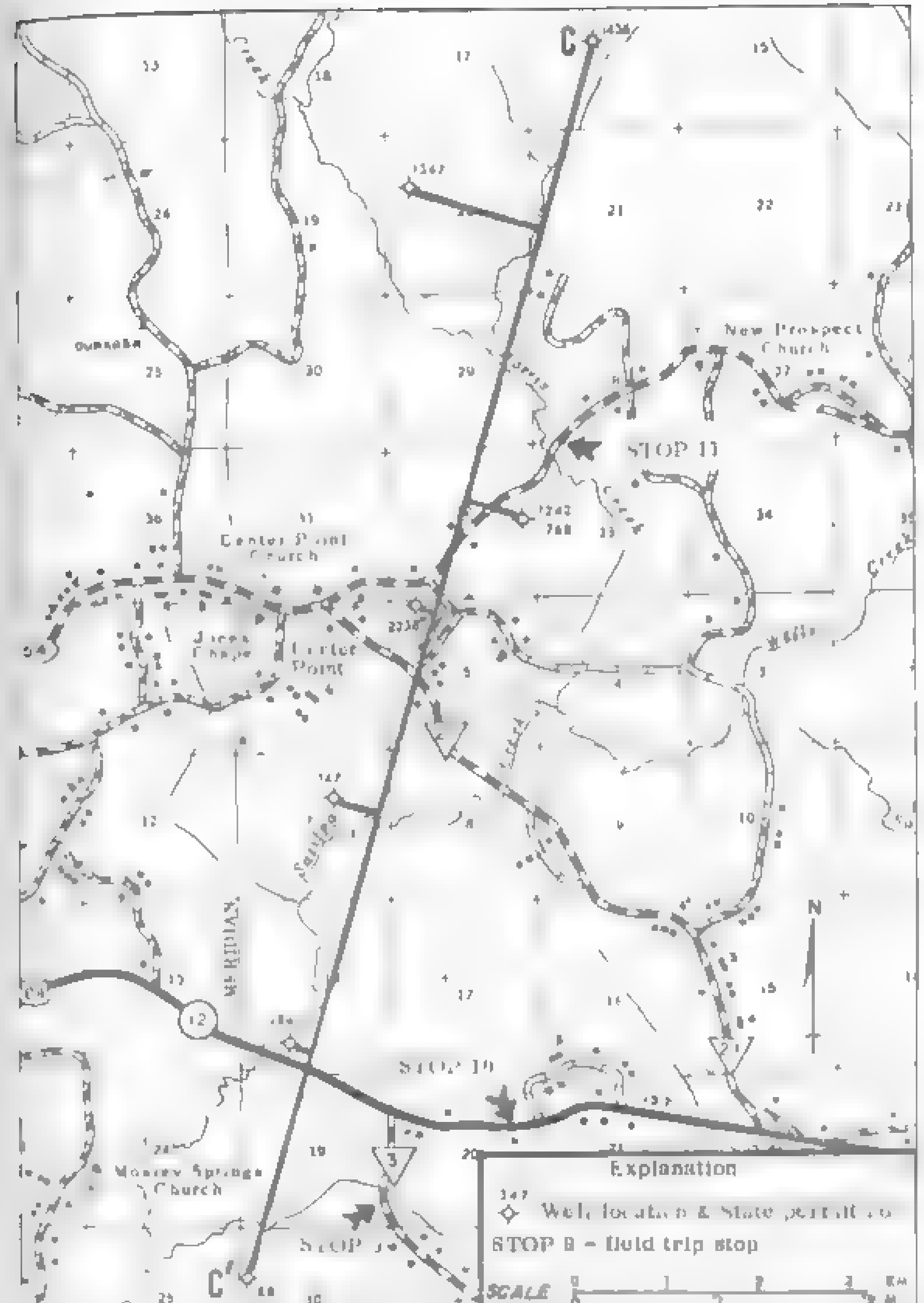


Figure 16.--Diagram showing [illegible]tions of oil test wells and cross-section C-C'.

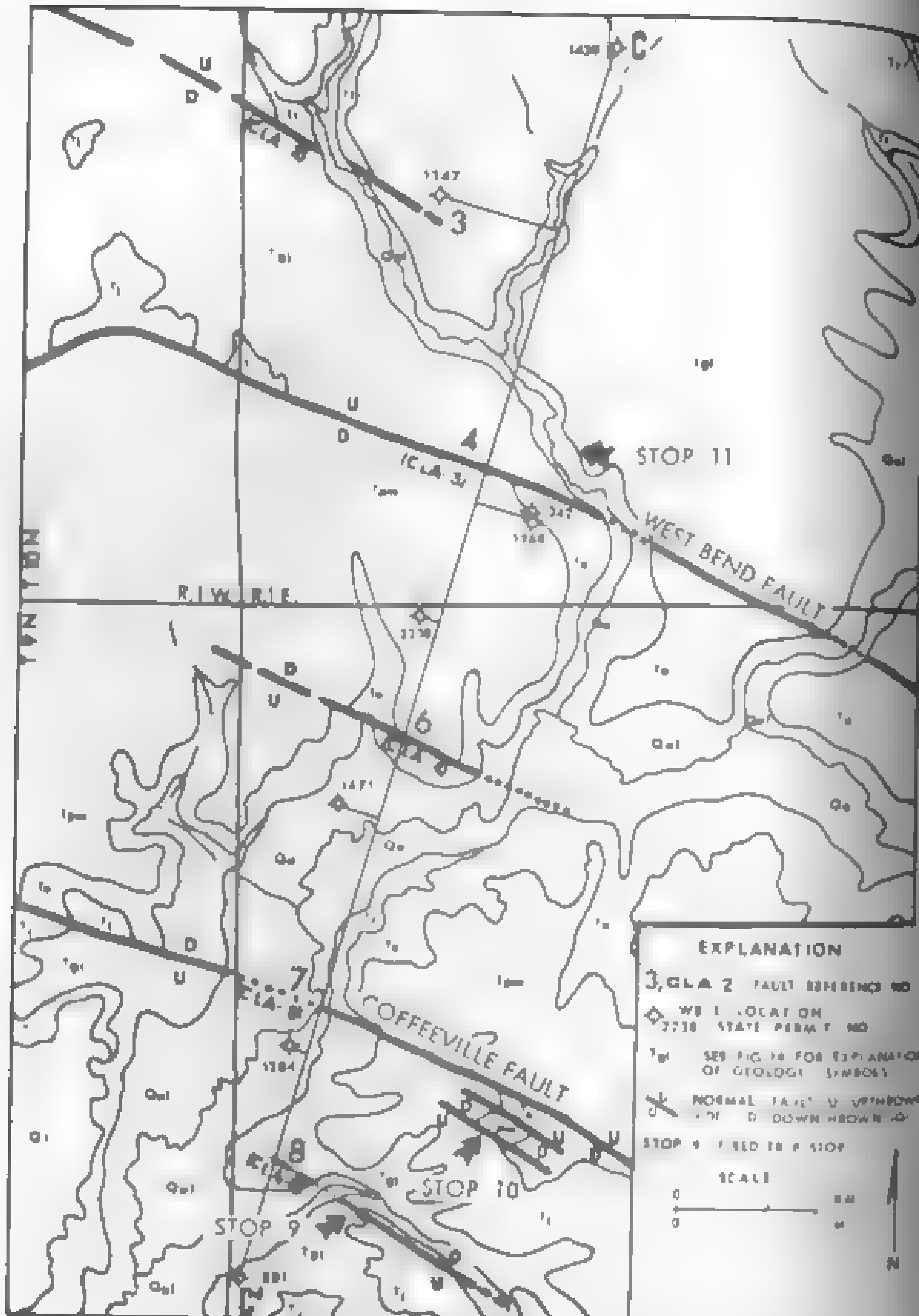


Figure 17.--Geologic map of the West Bend-Coffeeville fault zone in the vicinity of field trip Stops 9, 10 and 11. (Geology from Causey and Newton, 1971).

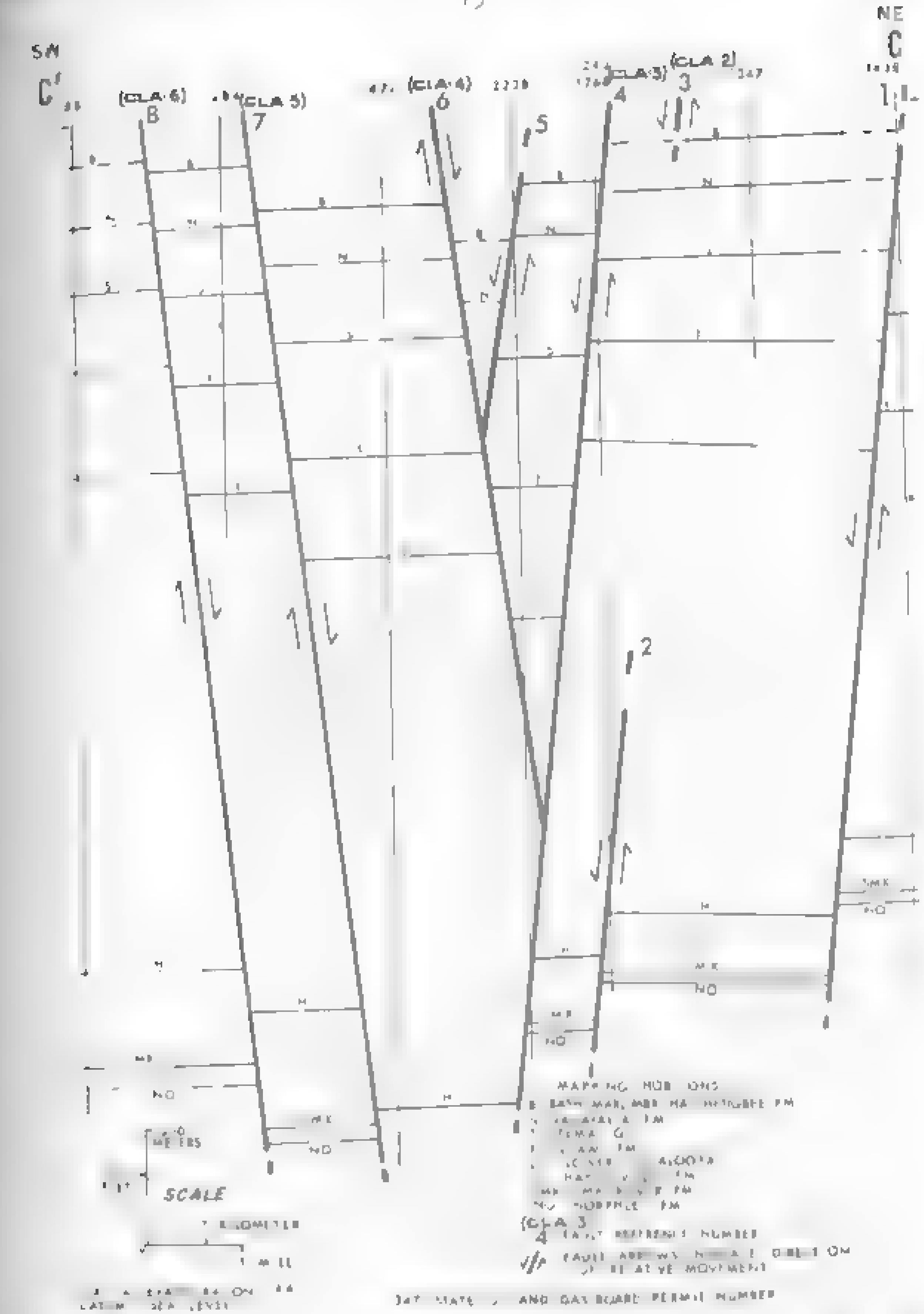


Figure 18.--Cross-section C-C'. Schematic diagram of West Bend-Coffeeville fault zone.

Fault no. 4 (West Bend fault, [illegible]) has been mapped on the surface for a distance of about [illegible] mi ([illegible] km). Vertical displacement along the fault at the surface in the vicinity of Stop [illegible] is estimated [illegible]. In the subsurface, fault no. 4 [illegible] at a depth of [illegible] ft ([illegible] m). Vertical [illegible] is approximately [illegible] ft ([illegible] m) [illegible] Group [illegible] out. The vertical [illegible] at the top of the [illegible] to be about [illegible] ft ([illegible] m) [illegible] fault no. [illegible] (West Bend fault) at the [illegible] in the subsurface, projection of the fault [illegible] indicates [illegible].

Fault no. 5 [illegible] in the subsurface [illegible]. However, [illegible] fault [illegible] than on the [illegible]. Therefore, [illegible] down-to-the-south fault (no. 5) [illegible] between faults no. 4 and 6.

Fault no. 6 ([illegible] Creek fault, north of [illegible] Highway 8[illegible]) [illegible] extends [illegible] surface from the [illegible] approximately [illegible] mi ([illegible] km). Vertical [illegible] approximately [illegible] ft ([illegible] m) [illegible] ([illegible] m) at the "Lower [illegible]" [illegible] regional dip of [illegible] ft/mi ([illegible] m/km) [illegible]. Apparent thickening between [illegible] "Lower [illegible]" horizons in well [illegible] between faults no. [illegible] and [illegible] of this interval. An [illegible] interval [illegible] the northeast [illegible] fault no. 4 (West Bend fault) at a depth of approximately [illegible] ft ([illegible] m).

Fault no. 7 (Coffeeville fault, [illegible]) represents the major down-[illegible] has been mapped for a distance of about [illegible] mi ([illegible] km) on the surface. Vertical displacement along the fault at the surface ranges from [illegible] ft ([illegible] m) [illegible] approximately [illegible] ft ([illegible] m) in sec. [illegible], T. [illegible] N., R. [illegible] E. ([illegible]), this fault [illegible] in the subsurface, vertical displacement of [illegible] is at [illegible] ft ([illegible] m) at the "Lower [illegible]" [illegible] greater than an estimated [illegible] ft ([illegible] m) at the [illegible] horizon. The displacement [illegible] in the subsurface are projected from nearby wells to the location of the fault on the surface; the actual fault does not appear to intersect any well in the immediate vicinity of S-[illegible].

Fault no. [illegible] ([illegible] Creek fault south of U.S. [illegible]) [illegible] exposed on the surface at Stop 9 (fig. 17, [illegible]) [illegible] it has a vertical displacement of approximately [illegible] ft ([illegible] m). On the surface, fault no. 8 has been mapped for a distance of about [illegible] mi ([illegible] km) in a NW-SE direction. In the subsurface, fault no. 8 does not appear to intersect [illegible] vertical [illegible] at the top of the [illegible] at the top of [illegible] Formation. [illegible] fault no. 8 into [illegible] rock [illegible] the interpretation [illegible] displacement [illegible] of faults in the subsurface and reverse dip associated with the anticline.

SUMMARY

[illegible]

[illegible] major faults are common.

Tracing the Cho-5 surface fault into the subsurface indicates that fault plane dips may vary with depth and also may change in rocks of different lithologies. Fault dips are probably greatest at or near the surface and much less steep in the subsurface. The Cho-5 fault, for example, has a dip of approximately [illegible]° on the surface, which decreases to 45° in lower Tertiary strata. The fault dip apparently increases to [illegible] to [illegible]° in the more competent rocks of Cretaceous age. In the Jurassic section this particular fault once again decreases in dip, which may be due to incompetent rocks of the Haynesville Formation or Louann Salt. Salt flowage and the general incompetent nature of this thick evaporite section apparently played a major role in fault movement. Additional studies are needed to determine if other surface faults have subsurface characteristics similar to the Cho-5 fault.

Major faults in the subsurface are generally parallel or subparallel to larger faults mapped on the surface. All of the faults present in the subsurface do not reach the surface. Some faults may die out at shallow depths and others may terminate against other faults. Some faults may be present on the surface but not yet mapped (see previous discussions in this paper on difficulties of mapping surface faults in the area). However, all faults known from outcrop in the two areas studied appear to be traceable down-dip where sufficient well data are available.

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Figure 14. Route Map

ROAD LOG

First Day, November 19, 1976

<u>Mileage</u> Interval	Cumulative	
		Leave Holiday Inn South, Tuscaloosa, on I-59 west. Road log begins at the intersection of Greensboro Avenue at the Southern Bypass.
	0.0	Junction of Greensboro Avenue and Southern Bypass (U.S. Highway 11); follow Southern Bypass west.
0.3	0.3	Junction Southern Bypass and Alabama Highway 69; turn right on U.S. Interstate Highways 20 West and 59 South.
4.0	4.3	City of Tuscaloosa water treatment facility on right removes iron from water obtained from four wells developed in the Coker Formation. The flat topography reflects the Quaternary terrace deposits that overlie the Coker Formation.
3.7	8.0	Center of bridge over the Warrior River, hills to west are underlain by the Coker Formation.
2.0	10.0	Detour; exit Interstate Highways 20 and 59, follow county road west to Junction with U.S. Highways 11 and 43.
1.0	11.0	Junction; turn left and follow U.S. Highways 11 and 43 South.
0.3	11.3	Junction with Tuscaloosa County Highway); continue south on U.S. Highways 11 and 43.
0.2	11.5	Grants Creek.
0.3	11.8	Contact between purple clay of the Coker Formation and sands in the overlying Gordo Formation.
5.5	17.3	Buck Creek.

1.0	18.3	Contact between the Gordo and the overlying Eutaw Formation.
1.5	19.8	Leave Tuscaloosa County; enter Greene County.
1.4	21.2	Glauconitic sand [illegible] thin-bedded carbonaceous clay of the Eutaw Formation overlies massive [illegible] purple clay in the Gordo Formation in roadcut on left [illegible].
0.5	21.7	Knoxville.
0.3	22.0	Overpass; turn right and continue west on Interstate Highways [illegible] and 59.
3.3	25.3	Slides in roadcuts resulting from the [illegible] of [illegible] in the Eutaw Formation.
10.8	36.[illegible]	Approximate contact between the Eutaw Formation and the overlying Mooreville Chalk of the Selma Group.
5.4	41.5	Exit Interstate Highways 20 and 59.
0.1	41.6	Junction with Greene County Highway 19; turn left [illegible] U.S. Highway [illegible].
3.0	44.6	Junction with U.S. Highway [illegible] and Greene County Highway [illegible]; turn right (west) [illegible] U.S. Highway [illegible]; [illegible] typical rolling topography developed on the Mooreville Chalk which is typical of the Black Prairie belt.
0.6	45.2	Boligee.
1.4	46.6	Crossing the Arcola Cuesta; the Arcola Limestone Member at the top of the Mooreville Chalk consists of thin, hard, fossiliferous limestone ledges interbedded with chalk; the ledges support the cuesta that extends across western Alabama.
0.6	47.2	Quaternary low terrace deposits of the Tombigbee River.
4.9	52.1	Center of the William Gorgas Bridge over the Tombigbee River. Leave Greene County; enter Sumter County; Epes city limits;

		Jones Bluff on the west side of the Tombigbee River is classic for exposures of the middle Demopolis Chalk.
0.5	52.6	Junction with Sumter County Highway 21; continue south on U.S. Highway 11.
0.3	52.9	Southern Railroad overpass; Demopolis Chalk exposed in cut.
0.1	53.0	Junction with Sumter County Highway [illegible]; continue south on U.S. Highway 11.
1.3	54.3	Demopolis Chalk dips to the west; the rolling topography, numerous bare chalk exposures, and abundant cedar trees are typical of the outcrop area of the Demopolis Chalk.
0.3	54.6	Gravel road to right; continue south on U.S. Highway 11.
1.1	55.7	Junction with Alabama Highway 39; turn sharp right (north) on Alabama Highway 39; upper parts of hills are underlain by the Bluffport Marl Member of the Demopolis Chalk.
0.5	56.2	Junction with gravel road; turn left (west) on gravel road; lower part of the Bluffport Marl Member of the Demopolis Chalk is exposed in roadcut.
0.4	56.6	STOP 1. Bridge over Interstate Highways 20 and 59. Normal fault in the lower unnamed member of the Demopolis Chalk located in [illegible] sec. [illegible], T. [illegible] N., R. [illegible] W., Sumter County.

STOP LEADER: D. M. Self

STOP 1 is located approximately 1 mi ([illegible] km) north of the nearest fault in the Livingston fault zone. Two normal faults are exposed which offset beds of the upper part of the lower unnamed member of the Demopolis chalk. The [illegible] fault strikes N 40° W and dips 60° NE, and has a displacement of approximately 20 ft (6.1 m). The fault plane is characterized by the presence of a thin layer of calcareous gouge as much as 2 in (5 cm) thick which is apparently derived from the chalk on either side of the fault. Slickensides are present on the chalk. The rake of these slickensides is apparently 90°, indicating almost total dip-slip movement.

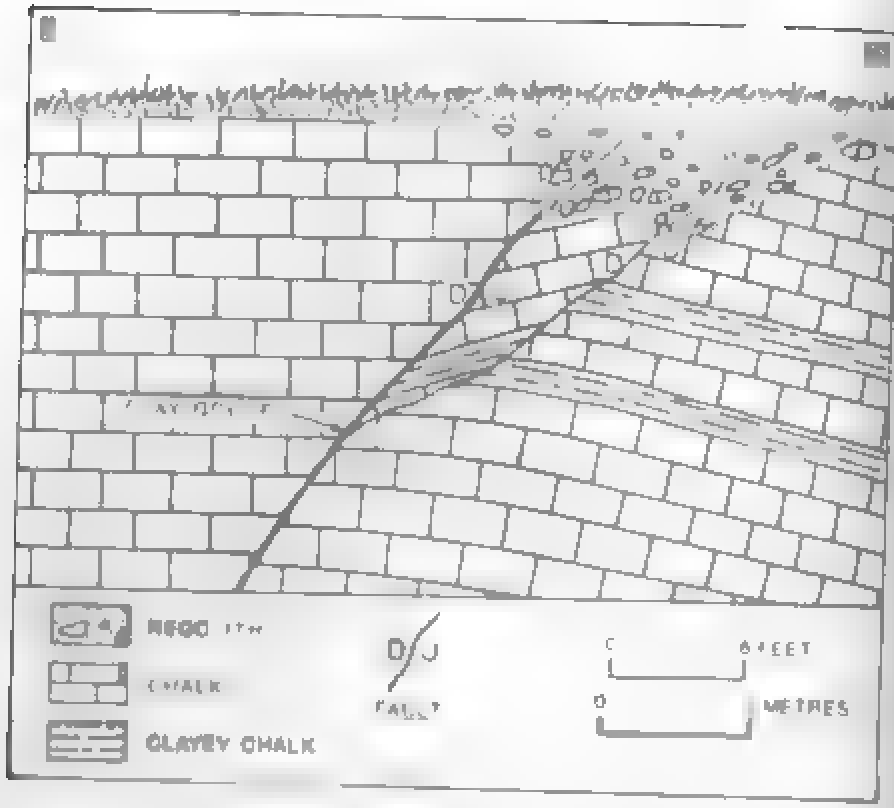


Figure 20.—Generalized diagram of normal fault exposed near the west end of the bluff at Stop 1.

The western fault also strikes northwest; however, it dips approximately 50° SW. Displacement is [illegible].5 ft (0.5 m). The chalk exhibits slickensides but there is no gouge.

Neither of the faults can be traced away from this exposure; however, the abnormally steep (approximately [illegible]° SW) dip of the marl beds in the chalk is indicative of the presence of additional faulting or folding.

0.6	57.2	Alternate Stop: Typical exposure of the Bluffport Marl Member of the Demopolis Chalk. Note the abundant macrofossil assembledge that is characteristic of the member. Turn around; return to U.S. Highway 11.
1.4	58.6	Junction of Alabama Highway 39 and U.S. Highway 11; turn right (south) on U.S. Highway 11.

[illegible]	59.[illegible]	Fossiliferous calcareous sand and sandy chalk of the Ripley Formation exposed in roadcut on left. Next 2.0 mi (3.2 km) is across the Livingston fault zone, a northwest-southeast trending zone of high-angle reverse faults which form a series of narrow horsts and grabens. The Livingston fault zone has been traced from near the Alabama-Mississippi State Boundary eastward across Sumter and Marengo Counties to the vicinity of Old Spring Hill. Maximum displacements exceed 75 ft (22.9 m); however, the average displacement appears to be between 20 and 40 ft (6.1 and [illegible] m).
1.2	60.[illegible]	Massive to thin-bedded fossiliferous, sandy chalk in the Prairie Bluff Chalk in a fault block exposed in roadcut to the left. Note the relatively steep reversal of dip (13° N).
2.2	62.4	Junction of U.S. Highway 11 and Alabama Highway 28.
3.1	65.5	Campus of Livingston State University on right.
1.[illegible]	66.7	Traffic light, turn left.
[illegible]	66.8	Junction of U.S. Highway 11 and Alabama Highway [illegible]; continue southeast on Alabama Highway [illegible].
[illegible]	[illegible]	Underpass (Southern Railroad).
1.[illegible]	68.8	Bridge over [illegible] Creek.
1.[illegible]	[illegible]	Hill on left capped [illegible] of the Clayton Formation.
[illegible]	[illegible].8	Bridge over [illegible] Creek.
0.7	73.5	Junction with Sumter County Highway [illegible]; continue south on Alabama Highway [illegible].
0.3	73.8	Junction with [illegible] road), turn left on [illegible] Prairie Bluff Chalk overlain [illegible] sand of the Clayton Formation in roadcut.
[illegible]	74.[illegible]	[illegible] sandy fossiliferous chalk in the Prairie Bluff Chalk exposed in road cuts.

1.0	75.2	STOP 2. Reverse fault in the Livingston fault zone located in SW¼ NW¼ sec. [illegible], T. 18 N., R. [illegible] W., Sumter County. See figure [illegible] in text.

STOP LEADER: D. M. Self

STOP 2 is located on the southwestern side of the Livingston fault zone. Here [illegible] reverse fault, which is typical of those of the Livingston fault zone, has thrust thin- to medium-bedded calcareous [illegible] sand of the Ripley Formation over massive [illegible] chalk of the Prairie Bluff Chalk. The fault plane [illegible] W, and dips 27° SW and is characterized by a [illegible] to [illegible] m thick zone of laminated [illegible] formed macrofossils are subrounded [illegible] derived from the more resistant beds of the Ripley Formation. The laminated sand and chalk is the product of [illegible] of the Prairie Bluff Chalk and the [illegible] of the Ripley Formation [illegible] is probably in excess of [illegible] ft ([illegible] m).

The exact age of faulting is unknown; however, the presence of undeformed macrofossils in the fault zone indicates that the faulting occurred shortly after the deposition of the Prairie Bluff Chalk, but prior to its lithification.

Note that both the Ripley and Prairie Bluff weather to an orange fine-grained mass [illegible] which makes recognition of faults extremely difficult except in fresh exposures. Continue northeast on gravel road.

0.5	75.7	Reverse fault with thin- to medium-bedded calcareous sand of the Ripley Formation thrust over massive sandy chalk of the Prairie Bluff Chalk exposed in road cut on left.
0.4	76.1	Ripley Formation dips east.
0.3	76.4	Medium olive gray sand in Ripley Formation exposed in road cut on right.
0.1	76.5	Weathered Ripley Formation exposed in road cut on left; dips to the west; small reverse fault exposed.
0.1	76.6	Weathered Ripley Formation exposed in road cut on left; dips east.
0.5	77.1	Series of minor reverse faults in weathered Ripley Formation in road cut on right.

1.3	78.4	High Ridge Cuesta. Rises as much as 200 ft (61.0 m) above the Black Prairie Belt to the northeast.
0.8	79.2	Approximate contact between the Ripley Formation and the underlying Bluffport Marl Member of the Demopolis Chalk. Abundantly fossiliferous, medium olive gray calcareous clay and clayey chalk in the Bluffport Marl is exposed in road cuts on left.
0.5	79.7	Lower unnamed member of the Demopolis Chalk exposed in bluff above stream and road cut.
2.0	81.7	Quaternary high terrace deposits unconformably overlie Demopolis Chalk in road cut on left.
0.6	82.3	Demopolis Chalk exposed on right.
[illegible]	82.4	STOP 3. Normal faults in lower unnamed member of the Demopolis Chalk, center of NW¼ sec. [illegible], T. 18 N., R. 1 E., Sumter County.

STOP LEADER: D. M. Self

Typical exposure of the middle part of the lower unnamed member of the Demopolis Chalk, with numerous normal and unresolved (normal ?) faults with small displacements. Fault [illegible] are undulatory, steeply dipping, and marked by calcite [illegible] which preserve slickensides. The faults strike from N [illegible] to N 75° W and intersect at several points. The [illegible] of the fault planes and similarity of the chalk on each side of the fault make it extremely difficult to determine if one fault is offset by another. Displacement along these calcite-filled fractures is usually less than 1 ft ([illegible] m) but may exceed 5 ft (1.5 m). Faults similar to the ones exposed at this stop have been traced over a distance of several hundred yards (meters) in exposures near Demopolis. Fault splays are numerous and the faults normally end in a mass of minor faults and joints rather than in a flexure. Continue northeast on same road.

[illegible]	83.0	Normal fault in the Demopolis Chalk in road cut on left. The apparent fault displacement here is approximately 8 ft (2.4 m). Note dip reversal of as much as [illegible] (SE) near the east end of the exposure.

0.[illegible]	83.[illegible]	Two normal faults displace beds of the Demopolis Chalk in road cut on left. Both fault planes dip steeply to the west. The easternmost fault divides into several minor faults as it passes beneath the road. These minor faults assume a more easterly strike south of the road.
0.3	83.4	STOP 4. Normal faults in the lower unnamed member of the Demopolis Chalk located in [illegible], T. [illegible] N., R. 1 E., Sumter County.

STOP LEADER: D. M. Self

A series of five normal faults displacing beds of the lower unnamed member of the Demopolis Chalk is exposed in the road cut and ditch on the north side of the road. These faults exhibit most of the characteristics commonly associated with normal and unresolved (normal ?) faults which occur in the Selma Group. The most prominent fault occurs near the center of the road cut. Its displacement is 5.5 ft ([illegible] m); it strikes N [illegible] E and dips [illegible] NW. The fault plane is characterized by a thin layer of clay gouge and slickensides.

A second less conspicuous fault, characterized by the presence of slickensided calcite, is located several yards (meters) east of the most prominent fault. This minor fault strikes N [illegible] E, dips approximately [illegible] W, and has a maximum observed displacement of approximately 2 in (5.[illegible] cm). Displacement along the fault decreases upward in the exposure until it disappears altogether approximately [illegible] ft ([illegible] m) above the base of the road cut. Whether this fault represents an early stage of faulting is unknown as its relationship to the other faults in the exposure is problematic.

Three other normal faults with displacements averaging 4 ft (1.2 m) are exposed in the eastern part of the road cut and ditch. They strike N [illegible] to [illegible] E and dip steeply. Very thin sheets of slickensided calcite are present in two of the three faults; the other fault is indicated by the presence of slickensides, drag folds, and displacement of beds.

As at Stops 1 and 2, there is no surface indication of faulting. Unlike previous exposures, there is some evidence which points to possible multistage faulting. Continue northeast on same road.

0.2	83.6	Demopolis Chalk exposed in road cut on right and in field to the south.
0.3	83.9	Abandoned gravel pit in terrace deposits of the Tombigbee River.

[illegible].3	84.2	Belmont; turn right on Sumter County Highway 23.
1.1	85.3	Halls Creek.
0.2	85.5	Normal fault in exposures north and south of road. Displacement is approximately 5 ft (1.5 m); strike is approximately N 30° W, dip is steep to the southeast.
1.4	86.9	Contact between lower unnamed member of the Demopolis Chalk and the upper Bluffport Marl Member of the Demopolis Chalk. Outcrops to the north and south contain numerous normal and unresolved (normal ?) faults.
[illegible].5	87.4	High terrace deposits of the Tombigbee River exposed in road cuts.
[illegible].4	87.8	Abandoned gravel pit on right.
1.[illegible]	88.9	Contact between Bluffport Marl and overlying Quaternary high terrace deposits of the Tombigbee River.
0.[illegible]	89.[illegible]	Bluffport Marl and Ripley Formation in apparent fault contact in the Livingston fault zone. Fault plane (?) not exposed. Low area south of road is underlain by Quaternary low terrace deposits of the Tombigbee River.
1.2	90.3	Bluffport Marl Member crops out in hillsides to right (north) of highway.
[illegible].7	91.0	Ripley Formation in graben in the Livingston fault zone caps hills south of the highway.
[illegible].1	91.[illegible]	Bluffport Marl Member of Demopolis Chalk exposed on left.
[illegible].4	91.5	Olive-gray calcareous sand of the Ripley Formation exposed in road cut on right.
1.2	9[illegible].7	Very light gray sandy chalk in Prairie Bluff Chalk exposed in road cut and ditch on left.
[illegible].1	92.8	Prairie Bluff Chalk exposed in road cut on left.

2.2	95.0	Coatopa. Junction of Sumter County Highway 23 and Alabama Highway 28; turn left (south) on Alabama Highway 28.
0.7	95.7	Prairie Bluff Chalk exposed in creek on north side of highway.
1.6	97.3	Junction with U.S. Highway 80, turn left (east) on U.S. Highway 80. Surface is developed on low terrace deposits of the Tombigbee River.
1.2	98.5	Contact between glauconitic limestone of Clayton Formation and dark clay of the Porters Creek Formation in stream on left (east).
0.9	99.4	STOP 5. Multistage faulting in right bank of Tombigbee River between Demopolis Rooster Bridge and the mouth of Sucarnoochee Creek (Old Moscow Landing), Sumter County (fig. 21, sections located on p. .

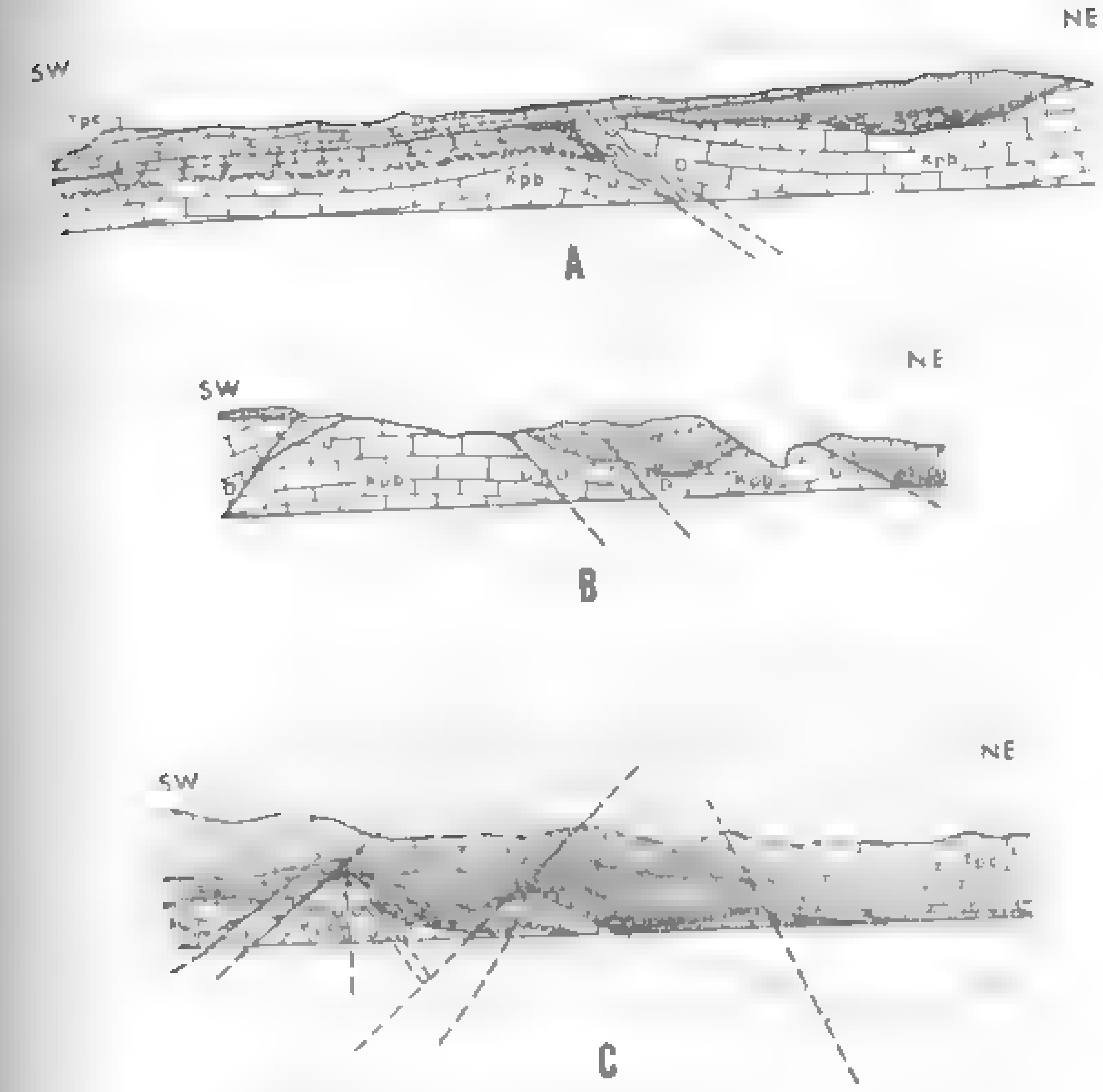
STOP LEADER: D. M. Self

CAUTION: THE BANK HERE IS STEEP AND DIFFICULT TO NAVIGATE, ESPECIALLY WHEN WET.

A spectacular sequence of folded and faulted Upper Cretaceous and Paleocene strata is exposed in the west bank of the Tombigbee River in the vicinity of Old Moscow Landing. Formations displaced by faults include the Prairie Bluff Chalk of Late Cretaceous age and the overlying Clayton and Porters Creek Formations of Paleocene age.

Faults of three distinct ages have been observed. The older faults exposed at Moscow Landing are normal and are characterized by a zone of plastic flow 4 to 40 in (10 to 102 cm) thick. They displace only the Prairie Bluff Chalk, apparently flatten with depth, and are truncated by the Cretaceous-Tertiary unconformity. The zones of plastic flow apparently represent deformation that occurred shortly after deposition of the Prairie Bluff, prior to lithofication of the chalk and deposition of the Clayton Formation. Displacement of these faults ranges from less than 1 ft (0.3 m) to possibly greater than 10 ft (3.0 m).

An intermediate stage of faulting is represented by a single fault that displaces the Prairie Bluff Chalk and terminates in the basal sandstone of the Clayton Formation. The fault is normal with as much as 4 in (10 cm) of displacement. The fault plane strikes E-W, dips 65° N, and is marked by a thin sheet of calcite which preserves slickensides.



1 inch = 25 feet (7.6 m)

Figure 21.--Three stages of normal faulting exposed at Moscow Landing. A: Post-Prairie Bluff – pre-Clayton fault marked by a 40 inch (1.0 m) zone of plastic flow. B: Intermediate stage fault that displaces both the Prairie Bluff Chalk and the basal sand of the Clayton Formation. C Post-Porters Creek faults displace all formations and one of the post-Prairie Bluff - pre-Clayton faults. Tpc - Porters Creek Clay; Tc - Clayton Formation; Kpb - Prairie Bluff Chalk.

The youngest faults are characterized by slickensided calcite-filled fractures in the more calcareous units (Prairie Bluff and Clayton). In clay in the Porters Creek Formation, the fault planes may be marked by a zone of limonite and selenite, or by a breccia zone. These faults displace all exposed formations and are thus considered to be post-Porters Creek in age. Like the faults of the Livingston fault zone to the north and peripheral fault zones to the south, these faults frequently produce narrow horsts and grabens which apparently parallel regional strike. Displacements may exceed 20 ft (6.1 m) on the larger faults. Although the faults exposed at Moscow Landing generally parallel those of the Livingston Fault Zone, the absence of reverse faulting and the fact that the nearest fault of the Livingston fault zone lie 4.6 mi (7.4 km) to the northeast seem to indicate that these faults represent either a southwestern splay of Livingston fault zone or an independent fault zone possibly paralleling the Livingston fault zone.

	99.4	Turn around. Travel west on U.S. Highway 80.
9.5	108.9	Sucarnoochee River.
9.2	118.1	Scratch Hill, Alabama, and junction of U.S. Highway 80 and Alabama Highway 17. Turn right onto access road.
0.3	118.4	Turn left (south) on Alabama Highway 17.
1.0	119.4	Junction Alabama Highway 17 and Sumter County 9. Continue south. Oak Hill Member of Naheola Formation, poorly exposed.
7.0	126.4	Exposure of Oak Hill Member of Naheola Formation.
3.6	130.0	Sumter County-Choctaw County boundary.
0.8	130.8	Exposure of lignite in the Oak Hill Member overlain by laminated beds of the Coal Bluff Marl Member of the Naheola Formation.
8.5	139.3	Sand bed in the lower part of the Tuscahoma Sand is exposed. Bed is a distinctive marker horizon containing large angular reworked clay boulders apparently indicating a high energy environment. Upper and lower contacts of beds are planar.

7.[illegible]	146.4	[illegible], Alabama. Continue south on Alabama Highway 17.
[illegible].5	[illegible]8.9	Junction with [illegible] County highway to Ar[illegible]. Turn left ([illegible]).
8.7	157.6	Contact of the T[illegible] and Lisbon Formations at an elevation of about [illegible] ft ([illegible]).
[illegible]	[illegible]58.	Downtown [illegible], Alabama.
[illegible]	158.5	Contact [illegible] and Lisbon Formations [illegible] elevation of about [illegible] ft ([illegible] m).
.5	[illegible]58.9	Intersection with [illegible] M[illegible] Ferry [illegible]. Contact of the [illegible] Lisbon Formations near the intersection.
[illegible]	[illegible].7	Contact [illegible] Lisbon Formations [illegible] about [illegible] ft ([illegible] m).
[illegible]	162.[illegible]	[illegible] Formations at an a[illegible] elevation [illegible] ft ([illegible]).
[illegible]	163.5	[illegible] Formations [illegible] normal fault, down [illegible] ft ([illegible]) to the south. [illegible] fault of [illegible] exposed at the surface extends across the highway in a covered zone between this point and Little Tallawam[illegible].
[illegible]	[illegible].1	[illegible] and Tallahatta Formations [illegible] Little [illegible] on the downthrown side of the [illegible] at an elevation of 90 ft (27 m). Displacement along the fault in this area [illegible] ft ([illegible] m).
0.7	164.8	Contact [illegible]
[illegible]	166.7	[illegible] Gilbertown fault [illegible]

STOP LEADERS: C. W. Copeland and J. G. Newton

At this locality, the Lisbon Formation of middle Eocene (Claiborne) age on the upthrown side of the fault is in contact with the Quaternary terrace [illegible] and the Red Bluff Clay of Oligocene (Vicksburg) age on the downthrown side. The vertical displacement [illegible] is approximately 150 ft (46 m). The fault [illegible] to the southwest and is one of the very few [illegible] of major faults that can be observed in southwest Alabama. Stop [illegible] is near the eastern end of the fault [illegible] ([illegible] and Newton, 1971) and is traceable on the surface [illegible] distance of [illegible] mi (10.3 km) in a westerly direction.

The Lisbon Formation exposed on the upthrown side of the fault is weathered gray [illegible] clay overlain by massive sand. [illegible] is exposed in the ditch along the road and [illegible] the roadcut on the downthrown side. The Red Bluff [illegible] weathered, sparsely fossiliferous, very pale [illegible] clay. Overlying the Red Bluff is a [illegible] gravelly sand that has been mapped as a Quaternary terrace [illegible]. The gravelly sand, if in place, implies [illegible] movement along the fault. The possibility exists that the material is not in place but has slumped to [illegible] resulting from the gradual disintegration of the Red Bluff. Also, the gravelly sand may not be of Quaternary [illegible] undifferentiated deposits of the Miocene Series. Field relations as presently known make it difficult to determine the age and stratigraphic position of the gravelly sand.

On the south side of the fault, near the base of the road cut, are features interpreted to be caused by the solution (collapse) of underlying carbonate units of Jackson and Oligocene age that distort bedding in the gravelly sand. Between this stop and the next road intersection [illegible] south limestone boulders of the Marianna Limestone and a few feet of the Red Bluff Clay are exposed. At the road intersection and below Daniels Fire Tower [illegible] terrace material is exposed in a large borrow pit.

Reference

Turner, J. D. and Newton, J. G., 197[illegible], Geologic map of Choctaw County, Alabama: Alabama Geol. Survey, Map [illegible].

0.5	167.2	Junction of unnumbered county road with Choctaw County Highway 9. Large borrow pit exposing Quaternary Terrace or Miocene on right. Greenish-gray clay of Red Bluff Formation exposed in low cuts near road. Turn right (north) on County Highway 9.

0.4	167.6	Weathered sand of Quaternary Terrace or Miocene on right.
0.[illegible]	167.8	Stop 6A (Alternate). Exposure of fossiliferous sand in the Lisbon Formation on the left. Outcrop is on the upthrown side of the fault examined at Stop 6. Elevation of the top of the cut is approximately 180 ft (55 m). Turn around and return to intersection south of Daniels Fire Tower.
[illegible]	168.7	Intersection of unnumbered county road and Choctaw County Highway 9.
0.4	169.1	Womack Hill community.
[illegible]	169.5	Womack Hill Gas Plant of Placid Oil Company.
2.6	172.1	Okatuppa Creek Public Use Area.
[illegible]	173.2	Barrytown community, turn left (south) on county road.
1.[illegible]	174.2	Souwilpa Creek.
0.[illegible]	174.4	Exposure of abundantly fossiliferous sand in the Lisbon Formation on the right.
1.1	175.5	Bear left at Y intersection.
[illegible]	177.8	Junction of U.S. Highway 84, turn left (east) on U.S. 84.
.8	178.6	Intersection of Choctaw County Highway 6 to Bladon Springs. Turn right (southeast). Contact of Tallahatta and Hatchetigbee Formations exposed on right. Axis of Hatchetigbee anticline is about 1.5 mi (2.4 km) southwest.
.5	179.1	Exposure of Tallahatta Formation.
1.7	180.8	STOP 7. Fault in Hatchetigbee Formation located near Bladon Springs in SE¼NE¼ sec. 18, T. 9 N., R. 2 W.

STOP LEADERS: D. M. Self and J. G. Newton

This locality is on the southeast-trending axis of the [illegible] anticline. Most faults in the area are essentially parallel to this axis. The fault exposed here, however, apparently trends N 70° E which intersects the axis of the

anticline at an angle of about 45°. The maximum displacement here is 3 to 5 ft (.9 to 1.5 m) with the upthrown side on the north. The clays and glauconitic sand exposed are in the upper part of the Hatchetigbee Formation. The rather distinctive gouge zone is about 6 ft ([illegible] m) wide with tension fractures on the north filled with white [illegible] material.

1.5	182.3	Junction of Choctaw County Highway 6 and Choctaw County Highway [illegible] in Bladon Springs. Continue east on Choctaw County 6.
3.3	185.6	Apparent collapse structure in Tallahatta Formation on left. Shape of feature is that of a very localized syncline. Limestone beds of any appreciable thickness are not known to occur in the Tallahatta or the underlying Wilcox (Sabine) or Midway Formations.
0.4	186.0	Junction of Choctaw County Highway 6 and U.S. Highway 84. Turn right (east) on U.S. Highway 84. Between here and the Tombigbee River, the Tallahatta Formation and lower parts of the Lisbon are well exposed in the road cuts.
3.3	189.3	Junction of Alabama Highway 69 and U.S. Highway 84 in Coffeeville, Alabama. Continue east on U.S. Highway 84.
0.3	189.6	Junction of U.S. Highway 84 and Alabama Highway 69 South. Continue east on U.S. Highway 84 to Grove Hill, Alabama.
20.0	209.6	Junction of U.S. Highway 84 and U.S. Highway 43 in Grove Hill, Alabama. Turn left (north) on U.S. Highway 43.
0.6	210.2	Travel Inn, Grove Hill, Alabama.

END OF FIRST DAY

ROAD LOG

Second Day, November 20, 1976

Mileage		
Interval	Cumulative	
0.0	0.0	Leave Travel Inn Motel in Grove Hill at 8:00 A.M., Saturday, November 20. Travel south on U.S. Highway 43 to Jackson, Alabama. Take business route (Alabama Highway 177) through Jackson to junction with Clarke County Highway 15.
15.0	15.0	Junction of Alabama Highway 177 and Clarke County Highway 15. Turn left (south).
0.6	15.6	Tracks of Southern Railroad.
[illegible]	15.8	Railroad tracks and lumber yard.
[illegible]	16.7	Y intersection, bear right.
3.4	[illegible]	STOP 8A. Richmond Branch. Outcrop of Marianna Limestone and Glendon Limestone Member of the Byram Formation on left (Cla-10 on pl. 2).

STOP LEADERS: J. G. Newton and C. W. Copeland

The exposure of highly inclined beds of the Marianna Limestone and Glendon Limestone Member of the Byram Formation [illegible], are located on the upthrown side of the Jackson [illegible] fig. 22). The lithology and elevations of the [illegible] and Byram and other geologic units cropping out [illegible] Clarke County Highway 15 in the vicinity of Richmond [illegible] and Salt Mountain in sec. 33, T. 6 N., R. 25 E., are shown on a geologic profile (fig. [illegible]) and a description of each of the exposed units modified from Toulmin and Newton ([illegible]963) is as follows:

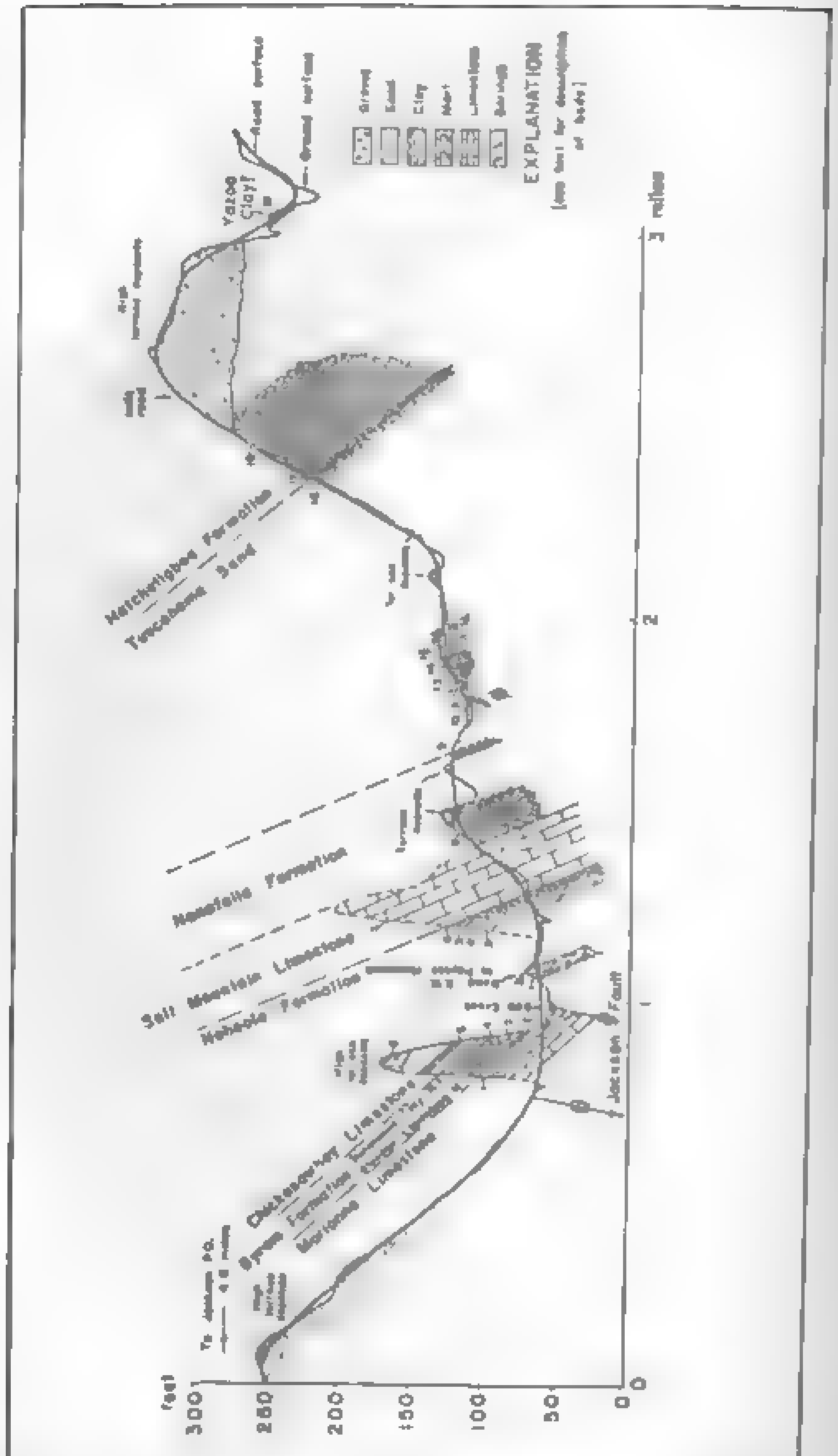


Figure 22.--Profile showing geology in the vicinity of Salt Mountain, Clarke County, Alabama. (Modified from Toulmin and Newton, 1963).

Geologic profile along Clarke County Highway 15 in the vicinity of Salt Mountain and Salt Creek in sec. 33, T. 6 N., R. 2 E. (fig. 22).

Bed descriptions modified from Toulmin and Newton (1963)

	Approximate thickness (feet)	(meters)
__Marianna Limestone__		
1. Limestone, white to grayish-yellow, weathers grayish orange, soft, massive, _Lepidocyclina mantelli_ (Morton) abundant throughout, a few tubular solution cavities near top	25+	7.6+
__Byram Formation__		
2. Limestone, white, weathers dark yellowish-orange, crystalline, cemented by calcite, fossiliferous. Middle consists of yellowish-gray coquina that contains abundant _Lepidocyclina_ sp. and _Ostrea vicksburgensis_ Conrad. Contains irregular solution pits and cavities. Upper part is poorly exposed greenish-yellow clay	20	6.1
__Chickasawhay Limestone__		
3. Limestone, grayish-yellow, argillaceous, glauconitic, soft, fossiliferous, poorly exposed	20	6.1
__High terrace deposits__		
4. Sand and gravel	10	3

JACKSON FAULT (Cla-10 on pl. 2)

__Naheola Formation__		
5. Sand, yellowish-gray, weathers dusky yellow to pale yellowish-orange, thin-bedded to laminated with some crossbedding, fine-grained, sparsely glauconitic, micaceous. Lower part is olive-gray very finely sandy, silty micaceous carbonaceous laminated clay. Data for lower part obtained from auger hole	5	1.5

	Approximate thickness (feet)	(meters)
6. Sand. Like bed 5. Grades upward into medium light-gray massive glauconitic micaceous sparsely sandy carbonaceous calcareous clay with sparse fossil prints in upper part	3	1
Salt Mountain Limestone		
7. Limestone, white, stained black on surface in places, massive, irregularly indurated, weathers and erodes to irregular surfaces, sparsely glauconitic, abundantly microfossiliferous in places. Rests on basal sand 1 to 3 in (2.5 to 7.5 cm) thick which is pale greenish-yellow, fine- to very coarse-grained, glauconitic, and fossiliferous, containing Discocyclina blanpiedi Vaughan, Pseudophragmina cookei (Vaughan), and [illegible] [illegible]rsae (Gabb)	60	18.2
Nanafalia Formation		
8. Clay, light-gray to medium-light-gray weathering various shades of gray and pale to dark yellowish-orange, thin-bedded to massive, very finely sandy, glauconitic, and micaceous throughout, subconchoidal fracture; contains some thin layers of very fine-grained sand that weather limonite plates from partings. A layer of fine- to coarse-grained abundantly glauconitic sand 1 ft (0.3 m) thick is present in lower part	70+	21+

Mileage

Interval	Cumulative	
0.2	20.3	Salt Creek.
[illegible]	20.5	STOP 8B. Salt Mountain Limestone. Exposure of Salt Mountain Limestone on east side of Clarke County Highway 15, at Salt Mountain in the SE¼ sec. 33, T. 6 N., R. 2 E.

STOP LEADERS: J. G. Newton and C. W. Copeland

The Salt Mountain Limestone generally ranges in thickness from 60 to 90 ft (18 to 27 m) and consists mainly of white very fossiliferous indurated limestone. The formation is [illegible] exposed at this locality on the upthrown side of the [illegible] fault in the vicinity of Salt Mountain (fig. 22). The Salt Mountain Limestone, previously considered Eocene in age, is now included in the Paleocene largely on the basis of [illegible] planktonic foraminiferal assemblage (Loeblich and [illegible], [illegible], p. 174-177). The correlation by Loeblich and [illegible] ([illegible]57) indicates that the formation is younger than the [illegible]ola Formation and older than the Nanafalia Formation in the overlying Eocene Series.

The plane of the Jackson fault is not exposed and only [illegible] approximate trace is known. The displacement exceeds [illegible] other fault in the Alabama Coastal Plain and at the [illegible] Salt Mountain is about 1,400 ft (427 m)(Toulmin, [illegible]). [illegible] displacement [illegible] northward and is about 50 ft ([illegible] m) near Jackson Creek, 7 mi (11.3 km) northwest of [illegible], Alabama.

[illegible] located in the vicinity of an old salt works [illegible] was the site of an extensive salt processing operation [illegible] Civil War times. [illegible] from this operation was obtained [illegible] and wooden casings of the brine wells [illegible] present in the vicinity but all other equipment [illegible] been removed. Three separate occurrences of salt [illegible] known in Clarke County and each was the site of [illegible] processing operation. The sites were referred to as the upper, central, and lower salt works. The central salt works are reported to have produced 88,000 tons of salt [illegible] during the Civil War ([illegible]dale, 1929). The brines [illegible] from about 25,000 to 45,000 parts per million sodium [illegible].

The springs and wells at the central salt works are in [illegible] of formations of the Wilcox Group but the brine [illegible] to be derived from lower formations possibly of [illegible] age. The brine possibly reaches the surface

through openings formed as a result of displacements which produced the Hatchetigbee anticline and Jackson fault zone. Continue south on Clarke County Highway 15.

References

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Loeblich, A. R., Jr., and Tappan, Helen, 1957, Planktonic Foraminifera of [illegible] from the Gulf and Atlantic Coastal Plains: U. S. Nat. Mus. Bull. 215, p. [illegible]

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_____ 1941, Eocene smaller Foraminifera from the Salt Mountain Limestone of Alabama: Jour. Paleontology, v. 15, p. 567-611.

_____ 1962, Description of section of Clarke County Highway 15 between Salt Creek and Jacksville on upthrown side of the Jackson Fault, in Gulf Coast Association of Geological Societies Guidebook, 12th Field Trip, p. 36.

Toulmin, L. D., and Newton, J. G., 1963, Profile showing geology along Alabama Highway 69 and Clarke County, Alabama: Alabama Geol. Survey Map [illegible].

1.2	21.7	Undifferentiated Wilcox exposed on left.
0.2	21.9	Turn around at dirt road on top of hill. Return to intersection of Clarke County Highway 15 and Alabama 177 in Jackson.
6.9	28.8	Junction of Clarke County 15 and Alabama 177. Turn right (northeast).
1.1	29.9	Junction of Alabama Highway 177 and and Alabama Highway 69. Turn left (northwest on Alabama Highway 69)
1.4	31.3	U.S. Highway 43 overpass.
2.2	33.5	Exposure of Marianna Limestone (Oligocene).
4.0	37.5	Contact of Hatchetigbee and Tallahatta Formations south of crest of Hatchetigbee anticline.
3.0	40.5	Salitpa community.
4.9	45.4	Contact of Hatchetigbee and Tallahatta Formations north of crest of Hatchetigbee anticline.
9.5	54.9	Junction of Alabama Highway 69 and U.S. Highway 84 in eastern part of Coffeeville. Turn right (east), on U.S. Highway 84.
1.0	55.9	Exposure of [illegible] Formation.
0.3	56.2	Deeply weathered [illegible] Moodys Branch Formation on the north side of road.
0.2	56.4	Deeply weathered [illegible] of the Moodys Branch Formation overlying weathered [illegible] on the north side of the road.
0.6	57.	[illegible]
1.2	58.2	[illegible] road on left (north); continue east on U.S. Highway 84.
1.2	59.4	[illegible] channel of Satilpa Creek.
1.0	60.4	[illegible] Clarke County Highway 3. Turn [illegible], on Clarke County 3.
0.6	61.0	[illegible] down- [illegible] south [illegible]

STOP [illegible]: [illegible] T. Newton [illegible]

At [illegible] at the [illegible] Formation [illegible] the [illegible] Moodys Branch on the [illegible] weathered [illegible] marl. The Lisbon Formation [illegible] composed mainly of clay, [illegible] The fault is well defined [illegible] exposed [illegible] downthrown [illegible] Moodys Branch on [illegible] both [illegible] After stop turn around and return to [illegible]

0.8	61.8	Junction of Clarke County Highway 3 and U.S. Highway 84. Turn right (east) on U.S. Highway 84.
0.6	62.4	Exposure of Pachuta Marl of Yazoo Clay. Bed [illegible] referred to in literature as "Pecten-Bryozoa bed."
0.3	62.7	STOP 10. Coffeeville fault and Miocene [illegible]. [illegible] to the Coffeeville fault located along U.S. Highway 84 near [illegible] Creek in the [illegible] sec. [illegible] The [illegible] northeast-dipping Coffeeville fault trends NW-SE with a displacement [illegible] the general area of about [illegible] ft [illegible].

STOP LEADERS: J. G. Newton and C. W. [illegible]

At this locality, the Red Bluff Clay and Marianna Limestone of Oligocene age crop out at similar altitudes in a cut on the north side of the highway. [illegible] Bluff consisting of calcareous glauconitic sandstone crops out at the west end of the cut. The Marianna consisting of light-gray fossiliferous limestone crops out at the east end of the cut. The presence of Pecten [illegible] shows that the limestone is upper Marianna. [illegible] the Oligocene units is a narrow graben consisting of mottled pink and white clay and sand of the Miocene Series. The maximum displacement is estimated to be [illegible] ft ([illegible] m). The Coffeeville fault is located in the nearby hill [illegible] to the east where the Marianna Limestone is [illegible] against the Miocene Series. Continue east on U.S. Highway 84.

0.1	62.8	Exposure of Marianna Limestone.
0.5	63.3	Exposure of sand of the Miocene Series.
0.3	63.9	Exposure of distorted beds in the Miocene Series.
0.5	64.4	Junction of U.S. Highway 84 with Clarke County Highway 21. Turn left (north) on Clarke County 21. Exposure of beds in the Miocene Series at the road intersection.
1.4	65.8	Junction with gravel road on right. Continue northwest on Clarke County Highway 21.
0.6	66.4	Oligocene limestone exposed in ditch on left. Limestone is possibly Chickasawhay or Glendon Limestone Member of Byram Formation.

0.3	66.7	Exposure of Miocene Series in road cuts.
0.8	67.5	Bridge over Satilpa Creek.
0.4	67.9	Alternate Stop. Intersection with unimproved dirt road on right in SE¼SE¼SW¼ sec. [illegible], T. [illegible] N., R. 1 E. About 20 ft ([illegible] m) of the Glendon Limestone Member of Byram Formation is exposed in hillside on northwest side of road.
0.3	68.[illegible]	Bucatunna Clay Member of Byram Formation exposed in road cut on right.
0.3	68.5	Small fault [illegible] sand and clay beds of the Miocene Series exposed in road cut on right. Light colored clays at [illegible] of cut may be weathered Chickasawhay Limestone.
0.1	68.6	Junction with gravel road on right. Beds of Miocene Series exposed in road cut. Continue northwest on Clarke County 21.
0.4	69.0	Beds of Miocene Series exposed in cut on right.
0.4	69.4	Junction of Clarke County 21 and Alabama Highway 154. Turn right (northeast).
0.4	69.8	Beds of Miocene Series exposed in road cuts.
[illegible]	[illegible]	Exposure of gravelly sands in Miocene Series.
[illegible]	70.[illegible]	Irregularly bedded Miocene sand and clay.
.3	[illegible]	[illegible] road [illegible] West Bend fault extends across [illegible] in next 0.4 mi ([illegible] km) but is not exposed.
0.4	71.3	STOP 11. West Bend Fault located at or near junction of county highway and Harris Creek in NE¼ sec. [illegible], T. [illegible] N., R. 1 E., and NW¼ sec. [illegible], T. [illegible] N., R. 1 E. Fault is normal, downthrown on the southwest, dips southwest, and trends southeast ([illegible] on p. [illegible]).

STOP LEADERS: J. G. Newton and C. W. [illegible]

At this locality the fault plane underlies alluvium in the basin of Harris Creek. Exposures on either side of the creek are about 1,300 ft (396 m) apart. The Lisbon Formation of Eocene age crops out on the northeast flank of the creek and fault and strata of upper Oligocene and lower Miocene age crop out on the southwest flank. The Lisbon Formation on the northeast flank consists of fossiliferous glauconitic finely sandy clay and clayey sand. Nearby on this same flank of the creek and fault, Lisbon strata extend 1[illegible] ft ([illegible] m, higher in altitude than that exposed adjacent to the fault. This places the exposure along the fault and basin in the lower half of the Lisbon. On the southwest flank of Harris Creek and the fault, the contact between the Oligocene and Miocene, is located 20 ft (6.1 m, higher in altitude than the nearby Lisbon that bounds the fault. Here, carbonate rocks in the Chickasawhay Limestone at the top of the Oligocene are overlain by massive sand and bedded marls and clays in the Miocene. The displacement [illegible] on the [illegible] displaced (one-half of the Lisbon Formation, the Jackson Group, and all but 20 ft [6.1 m] of the Oligocene Series) is estimated to be 300 ft (91 m).

0.2	71.5	Continue northeast on Highway 21 to residential road on left. **Turn around** and retrace route via **Alabama 154** and Clarke County 2[illegible] to U.S. Highway 84.
7.1	78.6	Junction of Clarke County Highway 21 and U.S. Highway 84. **Turn left (east).**
5.9	84.5	Zimco community and **junction with Clarke** County Highway 23. **Continue east** on U.S. Highway 84.
1.2	85.7	Miocene sediments exposed on left.
0.2	85.9	Junction with gravel road on left.
0.2	86.1	Highway crosses West Bend fault. Miocene Series on downthrown side of fault is in contact with highly weathered clayey sand of the Jackson Group. The red exposures are typical for southwest Alabama.
0.2	86.3	Exposure of the Pachuta Marl Member of the Yazoo Clay.
1.0	87.3	Exposure of the Pachuta Marl Member of the Yazoo Clay.
2.4	89.7	Grove Hill city limit.
1.2	90.9	Junction of U.S. Highway 84 with U.S. Highway 43. Turn left (north).
0.6	91.5	Travel Inn Motel and Pruitts Restaurant on left.
5.9	97.4	Exposure of Lisbon Formation.
2.3	99.7	Exposure of Tallahatta Formation.
0.7	100.4	Hatchetigbee Formation underlies the area.
0.3	100.7	Exposure [illegible] laminated sands and clays of the Hatchetigbee Formation.
2.5	[illegible]	Thomasville city limit.
4.3	1[illegible]7.5	Intersection of U.S. Highway 43 and Alabama Highway 5[illegible] Bear left on U.S. Highway [illegible] Highway crosses Hatchetigbee Formation.
1.5	109.[illegible]	[illegible] Marl Member of Hatchetigbee Formation and underlying Tuscahoma Sand in road cut on right.
0.7	[illegible]	[illegible] lignite in upper part of Tuscahoma Sand.
0.3	[illegible]	[illegible] lignite [illegible] in upper part of Tuscahoma Sand in road cut.
0.4	[illegible]	Clarke County-Marengo County boundary.
4.7	[illegible]	[illegible] community.
0.3	[illegible]	Mud Creek.
0.7	[illegible]	[illegible] Continue north on U.S. Highway [illegible]
[illegible]	[illegible]	Exposure of Tuscahoma Sand.
[illegible]	[illegible]	Exposure of Naheola Formation.
[illegible]	[illegible]	Exposure of Coal Bluff Marl Member of Naheola Formation.
[illegible]	12[illegible]	Oak Hill Member of Naheola Formation on left in road cut.
[illegible]	[illegible]	Junction with Marengo County Highway 47. Continue north on U.S. Highway 43.
[illegible]	[illegible]	[illegible] east of highway at site of "[illegible] tail" growth.

1.6	128.7	Junction with Marengo County Highway 33. Matthews Landing Marl Member of Porters Creek Formation exposed in hillside behind grocery store.
0.5	129.2	Hillsides bordering highway underlain by clay of Porters Creek Formation.
0.4	129.6	Outcrop of Porters Creek in stream bank east of highway. Dark gray massive clays as exposed are typical of the formation.
3.5	133.1	Junction of U.S. Highway 43 and Alabama Highway 69. Continue north on Highway 43.
0.2	133.3	Contact of Porters Creek Formation and underlying Clayton Formation.
0.4	133.7	Tracks of Louisville and Nashville Railroad.
0.2	133.9	Tracks of Louisville and Nashville Railroad. Depot restaurant on left.
0.5	134.4	Junction with Alabama Highway 28 in Linden, Alabama. Continue north on U.S. Highway 43.
0.9	135.3	Exposure on the right of cross-bedded sand in the Ripley Formation.
0.3	135.6	Chickasaw Bogue Creek.
0.2	135.8	Providence community.
0.9	136.7	Junction of Alabama Highway 69 and U.S. Highway 43. Continue north on U.S. Highway 43 toward Demopolis.
1.3	138.0	Chickasaw State Park on right.
4.1	142.1	Junction with Marengo County Highway 1. Continue north on U.S. Highway 43.
0.6	142.7	Exposure of weathered sand in the Ripley Formation in the vicinity of the Livingston fault zone.
0.1	142.8	Valley is a structural horst underlain by what is probably the Bluffport Marl Member of the Demopolis Chalk.
0.05	142.85	Exposure of the Ripley Formation.

[illegible]	142.95	[illegible] Horst in Livingston [illegible] Bluffport Marl Member of the [illegible] Chalk is exposed in the valley to the west.
[illegible]	[illegible]	[illegible] with Marengo County Highway 35. Continue north on U.S. Highway 43.
[illegible]	[illegible]	[illegible] Marl Member in valleys, Ripley Formation [illegible] near north edge of Livingston fault zone.
[illegible]	[illegible]	Area underlain by the Bluffport Marl Member of the Demopolis Chalk. Rolling topography is typical of the unit.
[illegible]	[illegible]	Contact of the unnamed lower member of the Demopolis Chalk and the Bluffport Marl Member.
[illegible]	[illegible]	[illegible] with Marengo County Highway 54 on right. Continue north on U.S. Highway 43.
[illegible]	[illegible]	[illegible] upper part of the [illegible] of the Demopolis Chalk [illegible] to Bluffport that are much less fossiliferous.
[illegible]	[illegible]	[illegible] Demopolis city [illegible] exposed in cuts. [illegible] the north [illegible]
[illegible]	[illegible]	[illegible] Highway [illegible] and 80. Continue north on [illegible] Street.
[illegible]	[illegible]	[illegible] on left.
[illegible]	[illegible]	Intersection of South Cedar Street and [illegible] Street. Turn left on E. Capitol Street.
[illegible]	[illegible]	Intersection [illegible] Street and N. [illegible] turn right [illegible] Highway 43 toward [illegible] square on left.

0.6	151.2	South end of bridge over Lake Demopolis backwater. City water well in brick house on left completed in Eutaw Formation at 8[illegible] ft ([illegible] m).
1.5	152.7	Center of Wm. P. King Bridge over Warrior River. Leave Marengo County; enter Greene County.
1.5	154.2	Junction with road to Demopolis Reservoir. Continue north on U.S. Highway 43. Highway traverses along flood plain terrace of the Warrior and Tombigbee Rivers. Lake Demopolis backwater alongside highway.
2.9	157.1	Railroad overpass and junction with Greene County Highway 4. Continue north on U.S. Highway 43.
6.8	163.9	Junction with Greene County Highway 19. Continue north on U.S. Highway 43.
0.8	164.7	Junction with Greene County Highway 4 again. Continue north on U.S. Highway 43.
1.7	166.4	Strawberry Hill Plantation. Arcola Limestone Member of Mooreville Chalk exposed in ditch on right side of road.
0.1	166.5	Exposure of lower unnamed member of Mooreville Chalk.
1.1	167.6	Arcola Limestone Member of the Mooreville Chalk exposed at crest of hill. The Arcola Limestone Member at the top of the Mooreville Chalk, represents a transition lithologically from the underlying clayey, impure chalks of the Mooreville to the relatively pure chalks of the Demopolis. The Arcola supports a cuesta extending across western Alabama, which facilitates mapping the chalk of the Selma Group. The Arcola in this locality is badly weathered and approximately 4 ft (1.[illegible] m) of the unit is exposed in the top of the road cut. The Arcola consists of thin, hard, fossiliferous limestone ledges interbedded with softer chalk. Fresh exposures contain Exogyra ponderosa and abundant internal molds of pelecypods and gastropods.

[illegible] County Highway 10 [illegible] Paved road [illegible] Hunting [illegible] privately owned or [illegible] Alabama.

[illegible] in road cut.

[illegible] in road cut.

[illegible] in road cut.

[illegible] Chalk exposed [illegible]

[illegible] tree [illegible] Formation.

[illegible] creek. [illegible] of the [illegible] prairie [illegible] when [illegible] of [illegible] abundant. [illegible] and dairy [illegible]

[illegible] right. Road [illegible] Warrior [illegible] Chalk and [illegible] Member of [illegible] north on [illegible]

[illegible] in road cut.

[illegible] Highway 43 and [illegible] northwest [illegible]

[illegible] Mooreville [illegible]

[illegible] Eutaw, Alabama.

0.1	179.1	Greene County Courthouse on left. At this point the route taken in returning to Tuscaloosa is optional. The trip will either return to Tuscaloosa by traveling northwest on Alabama Highway 14 to the junction with Interstate 59, or will turn right and proceed to Tuscaloosa along U.S. Highways 11 and 43. The road log identifies exposures along U.S. Highways 11 and 43. The road cuts along the Interstate route have all been landscaped.
0.1	179.2	Turn right on U.S. Highway 11.
0.3	179.5	City of Eutaw well in fenced enclosure on left. Begins at Eutaw-Mooreville contact, yields water from the Eutaw Formation; penetrates top of Tuscaloosa Group at 3[illegible] ft ([illegible]6.5 m).
0.3	179.8	Eutaw city limit, leaving Black Prairie Belt and entering Fall Line Hills.
4.2	184.0	Junction Greene County Highway 37 on left. Continue northeast on U.S. 11.
1.1	185.1	Junction with Greene County Highway 59. Continue northeast on U.S. 11 and 43.
1.5	186.6	Sugar Loaf Hill. Exposures of sand in the Eutaw Formation.
2.5	189.1	Junction with Greene County Highway 57. Continue northeast on U.S. 11 and 43.
1.2	190.3	Exposure of clay in the lower part of the Eutaw Formation.
0.3	190.6	Quaternary terrace deposits overlying clay of the Gordo Formation of the Tuscaloosa Group.
1.4	192.0	Interstate Highway 59 overpass.
0.4	192.4	Knoxville community.
0.5	192.9	Exposure of glauconitic sand and thin-bedded carbonaceous clay of the Eutaw Formation overlying purple clay of the upper part of the Gordo Formation.
1.4	194.3	Leave Greene County; enter Tuscaloosa County.

0.3	211.1	Entrance to B. F. Goodrich Rubber Company plant. Water wells supplying the plant are developed in terrace deposits. Pottsville Formation penetrated at 74 ft (22.6 m).
1.1	212.2	Stillman College (Presbyterian) on right. Founded in 1876.
0.2	212.4	Intersection of 15th Street and U.S. Highway 11 and 43. Bear right on 15th Street.
1.0	213.4	Intersection fo 15th Street and 24th Avenue. Continue straight (east) on 15th Street to intersection with McFarland Boulevard.
1.7	217.3	Entrance of Holiday Inn (South).

END OF FIELD TRIP

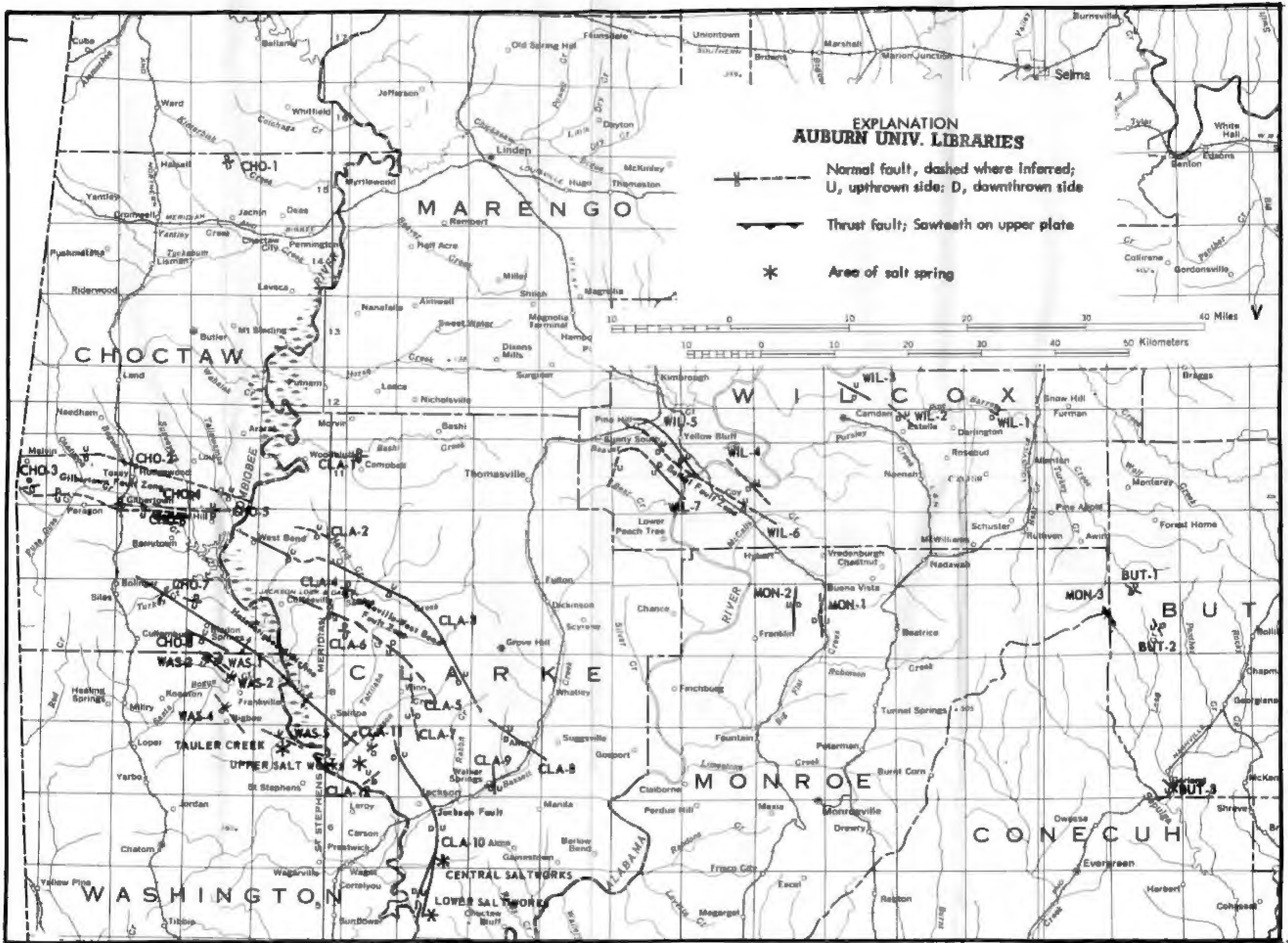

Plate 2.—Map showing surface faults in southwestern Alabama and location of salt springs. (From Copeland, 1975)

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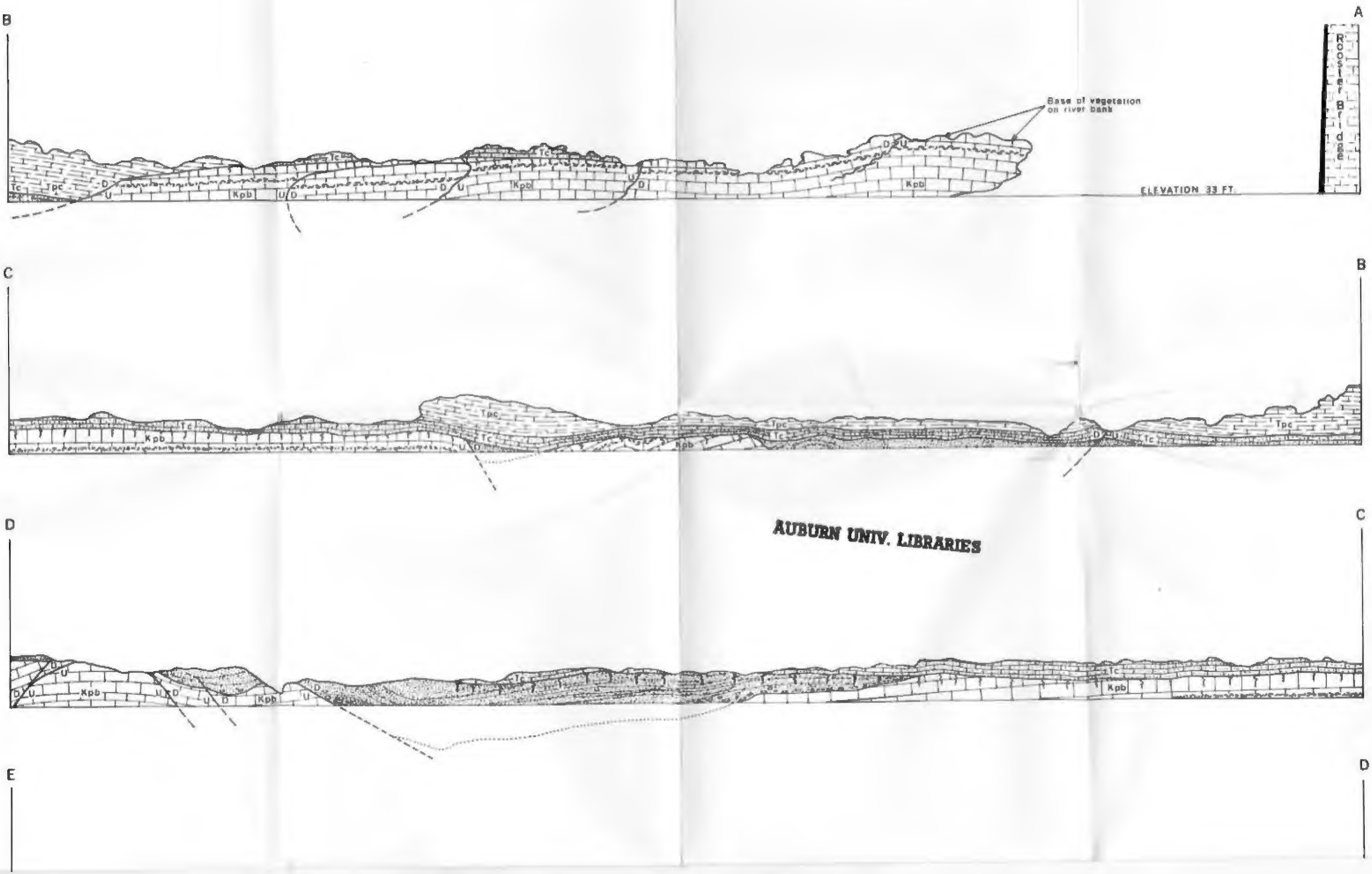

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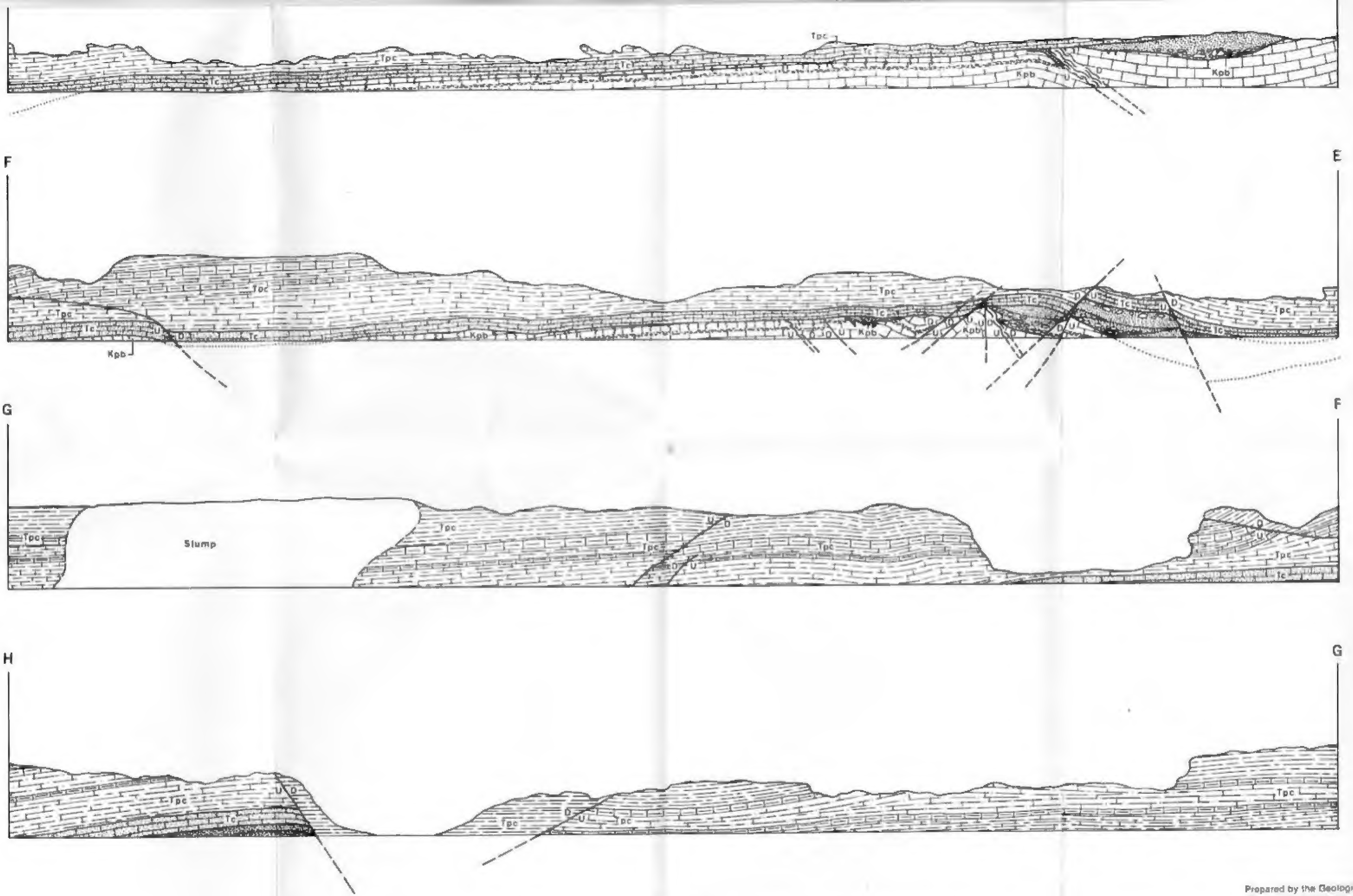

Portion of Section Exposed at Moscow Landing, Tombigbee River

(From Self, D. M., 1975)

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